Use of the NASA KSC 50-MHz ST Profiler for Operations Support to Spaceflight — Part I, Characterization of the Instrument

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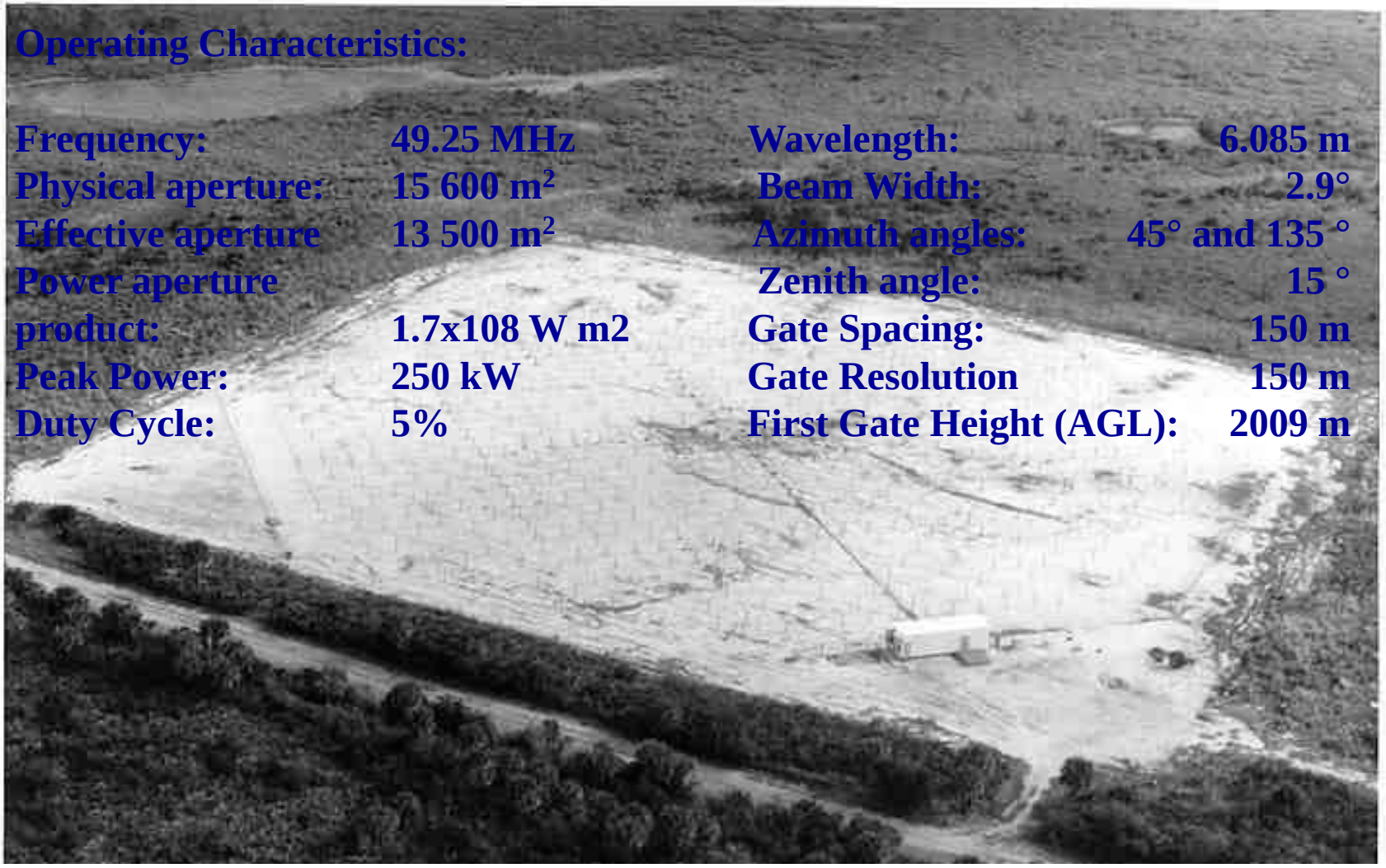
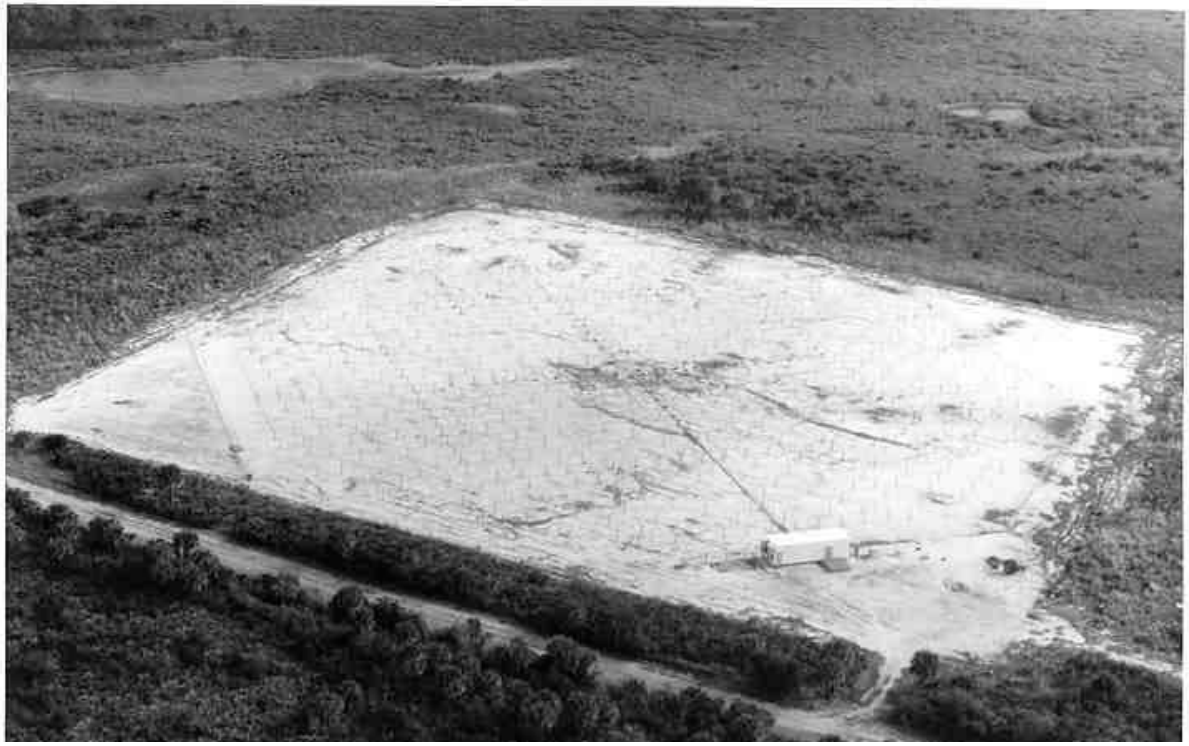
KSC 50-MHz Profiler



Operating Characteristics:

Frequency:	**49.25 MHz**	**Wavelength:**	**6.085 m**
Physical aperture:	**15 600 m^2**	**Beam Width:**	**2.9°**
Effective aperture	**13 500 m^2**	**Azimuth angles:**	**45° and 135 °**
Power aperture		**Zenith angle:**	**15 °**
product:	**1.7x108 W m2**	**Gate Spacing:**	**150 m**
Peak Power:	**250 kW**	**Gate Resolution**	**150 m**
Duty Cycle:	**5%**	**First Gate Height (AGL):**	**2009 m**

KSC 50-MHz Profiler



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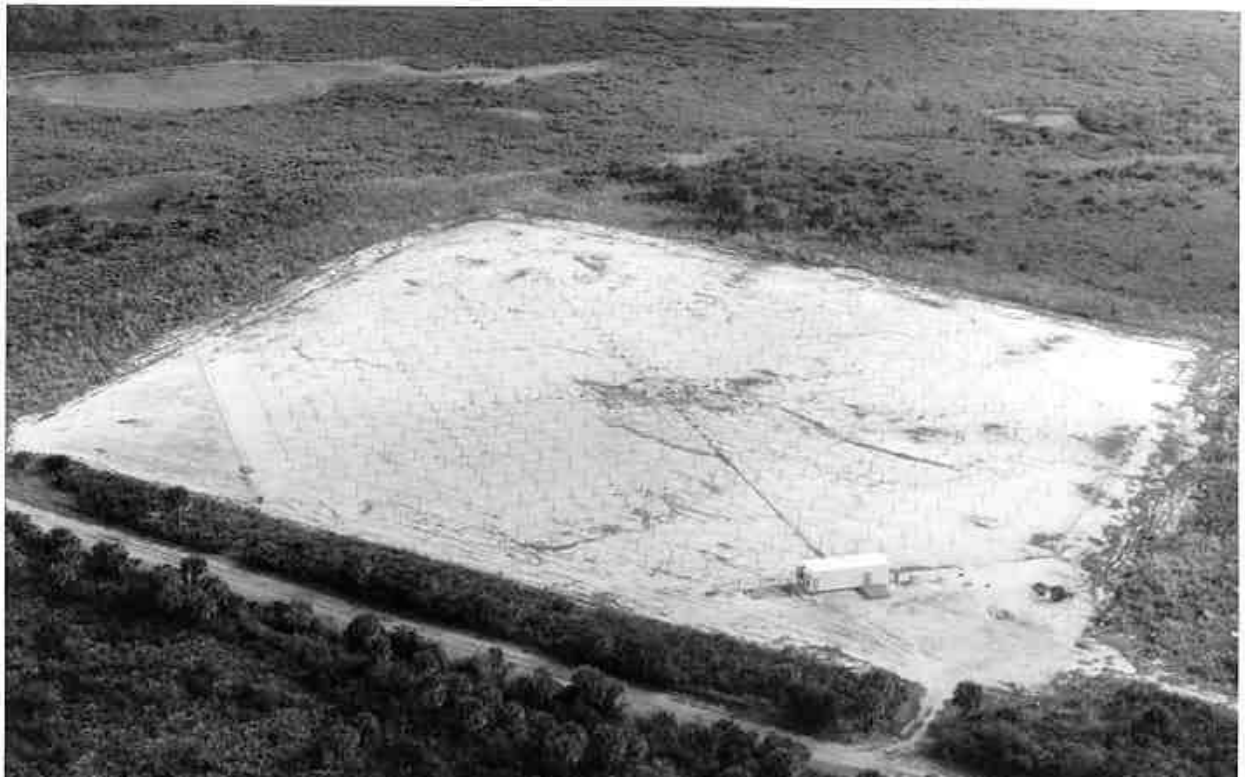


Accuracy of the KSC 50-MHz Profiler

The KSC profiler has an RMS error near 1 m s^{-1}

Internal Estimates:

- Spectral Width = 0.65 m s^{-1} per beam. Resulting RSS component error = 0.92 m s^{-1}
- Standard deviation of vertical speed = 0.37 m s^{-1} (about a mean of zero)

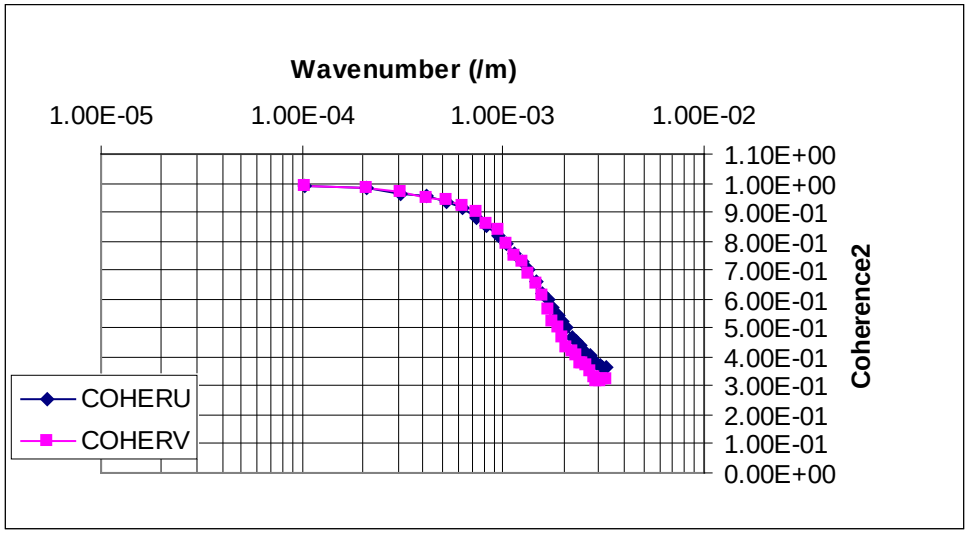
External Estimate:

- Comparison with Jimspheres ~ 1 m s^{-1}

Jimspheres are radar-tracked balloons that provide high vertical resolution wind estimates. Jimsphere's provide the operational wind estimates prior to vehicle launch.

Schumann, R. S. et al. J. Atmos. Oceanic Technol., **16**, 532-549

Resolution of the KSC 50-MHz Profiler



KSC profiler resolves vertical scales as small as 300 to 500 m.

Details in *J. Atmos. & Oceanic Technol.* **16**, 1273-1278, 1999.

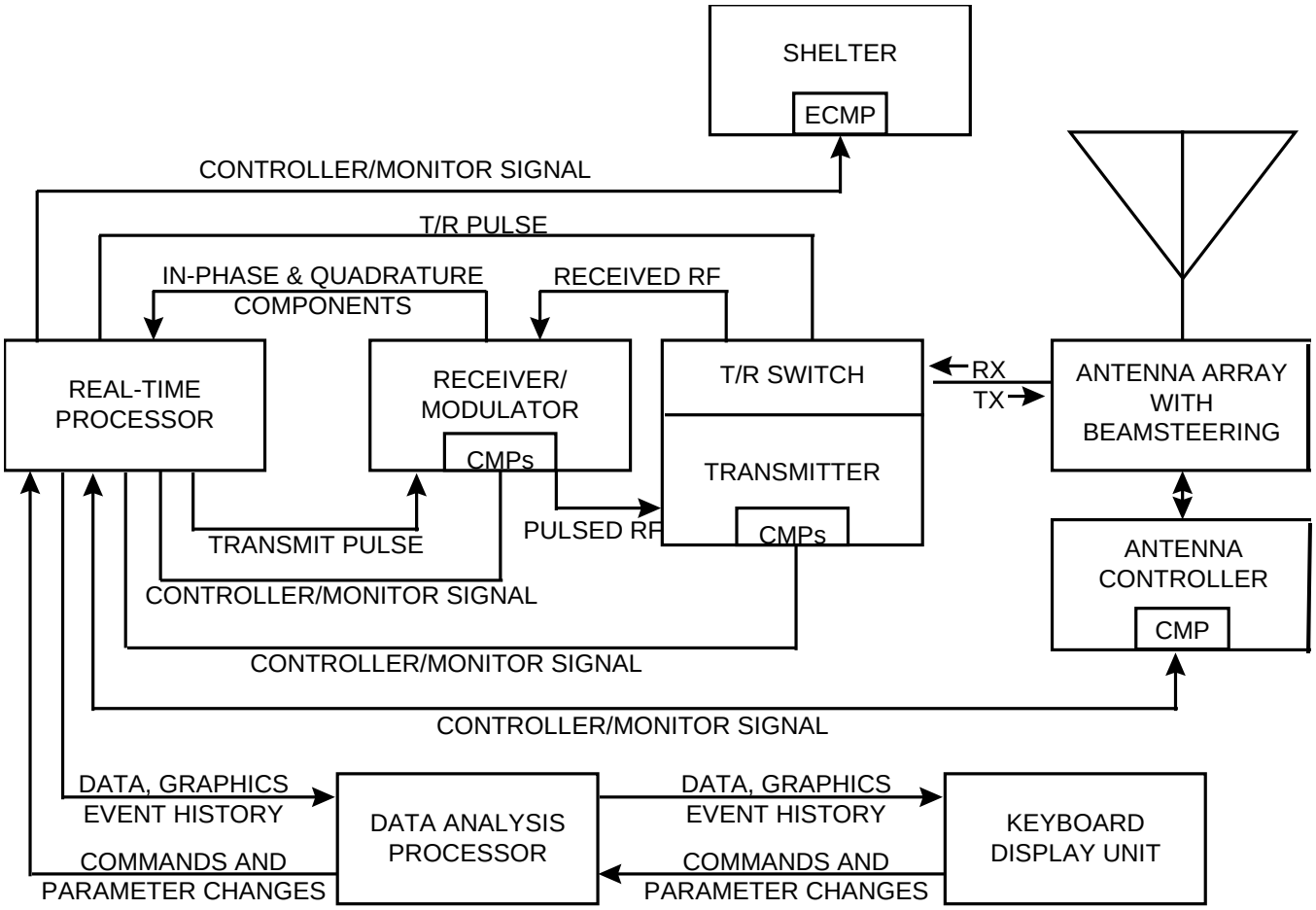
Methodology:

- Coherence analysis on consecutive wind profiles
- Coherence squared threshold of 0.5
- Consecutive profiles spaced 5 minutes apart, assumed coherent.

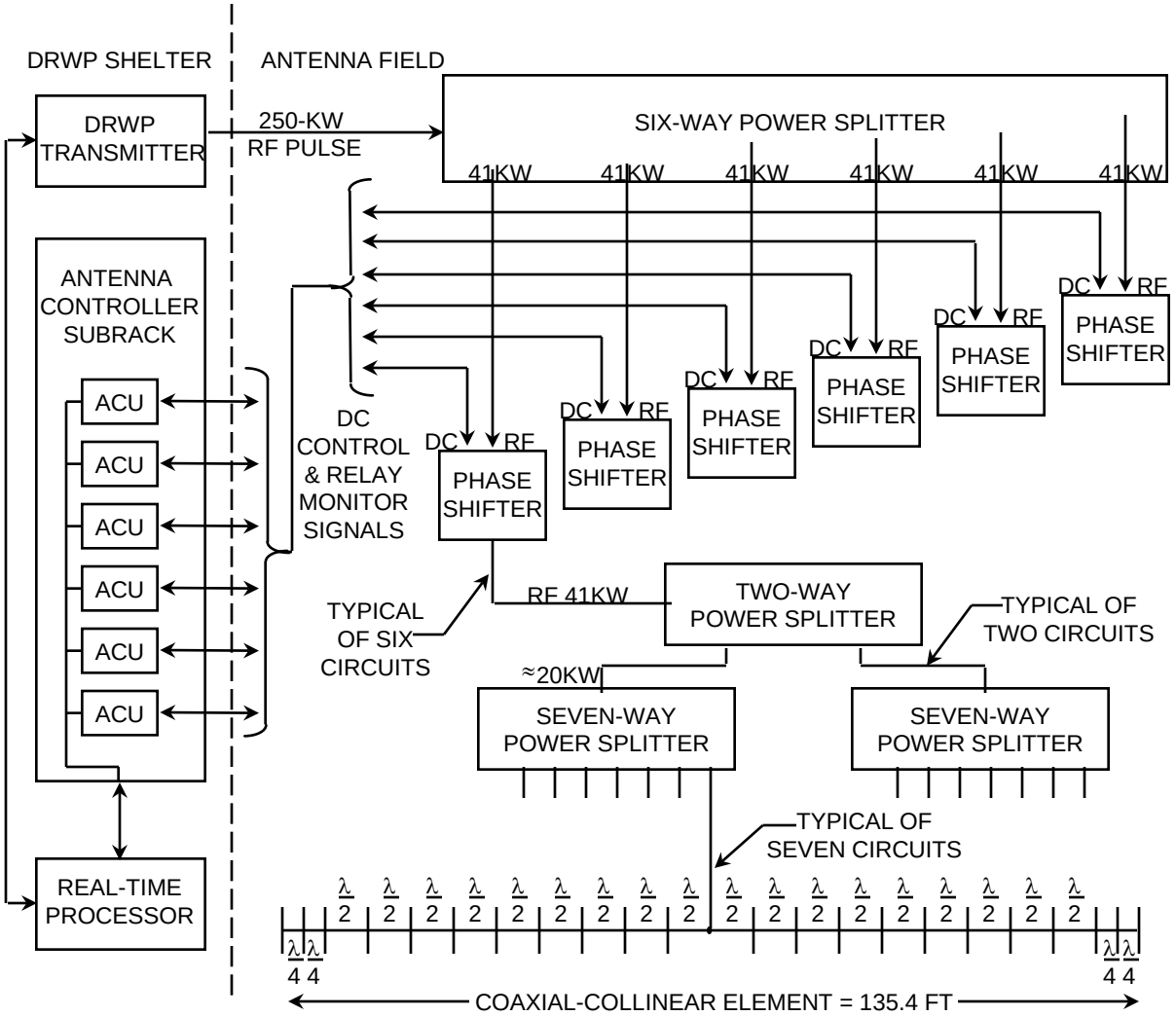
Reliability of the KSC 50-MHz Profiler

- Instrument down time is normally less than 2%
- Two antenna outages over a ten-year period (one due to hurricane damage, one for scheduled replacement) lasted 8 weeks.
- Communications essential for day-of-launch manual quality control have not been consistently reliable. This is a failure of the communications lines, not the instrument.

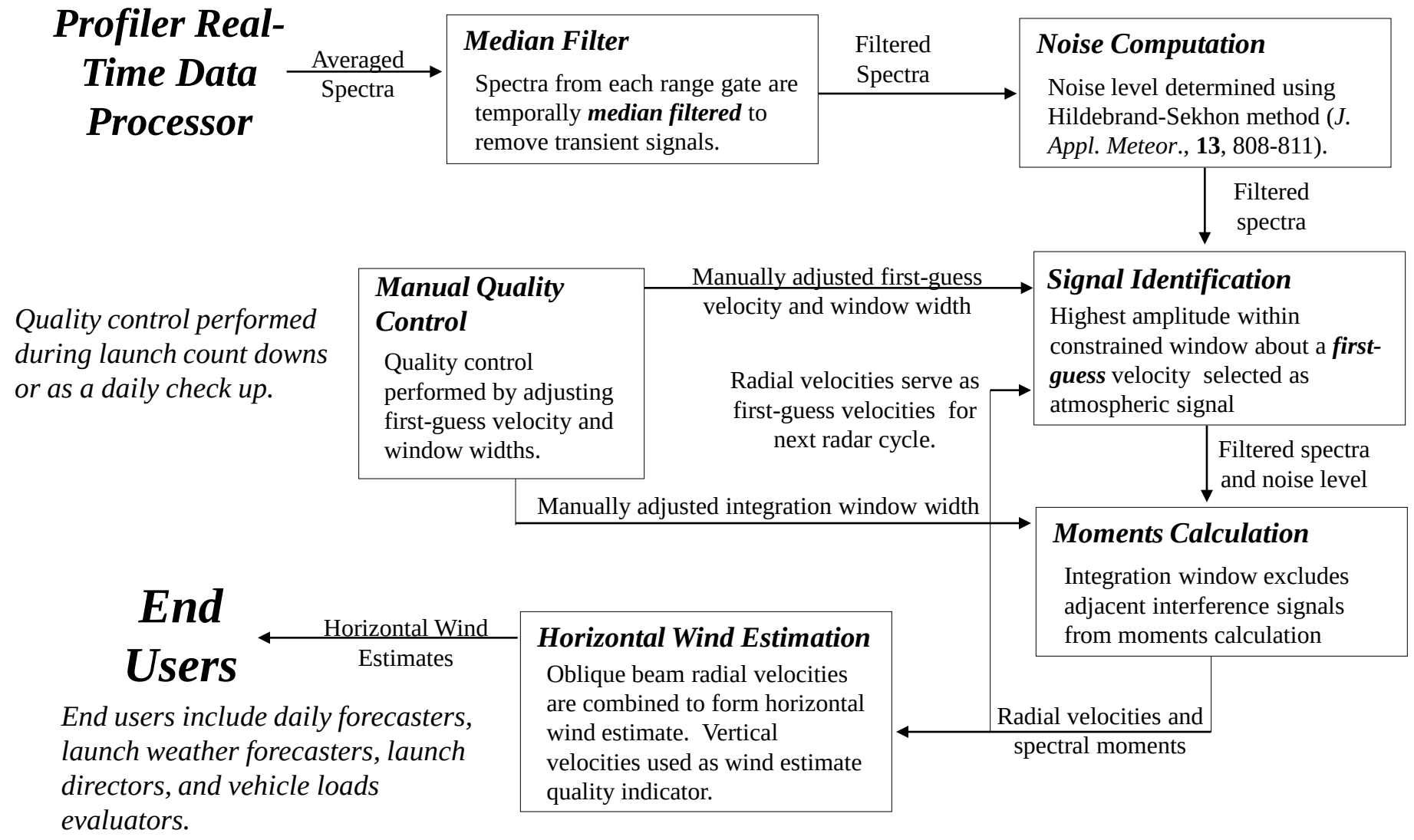
Radar Block Diagram



Antenna Block Diagram



Median Filter-First Guess Algorithm



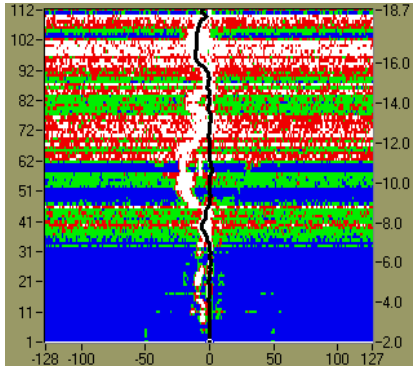
MFFG Manual QC Methodology

Manual QC Motivation:

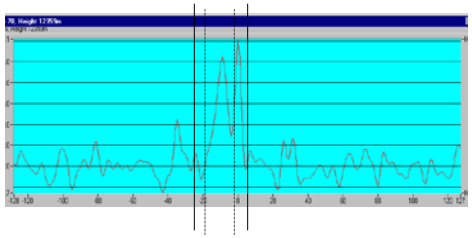
- Manual quality control is optional. The first-guess and associated windows tend to keep the radial velocity on track once they are set correctly.
- Manual quality control is provided prior to launch due to criticality of data. If discrepancies between profiler and balloons exist, they must be verified.
- For standard forecasting use, the quality control is performed once daily to ensure the profiler is on track.

Manual QC Process:

1. Examine each beam's radial velocity profile with respect to the median filtered spectral densities

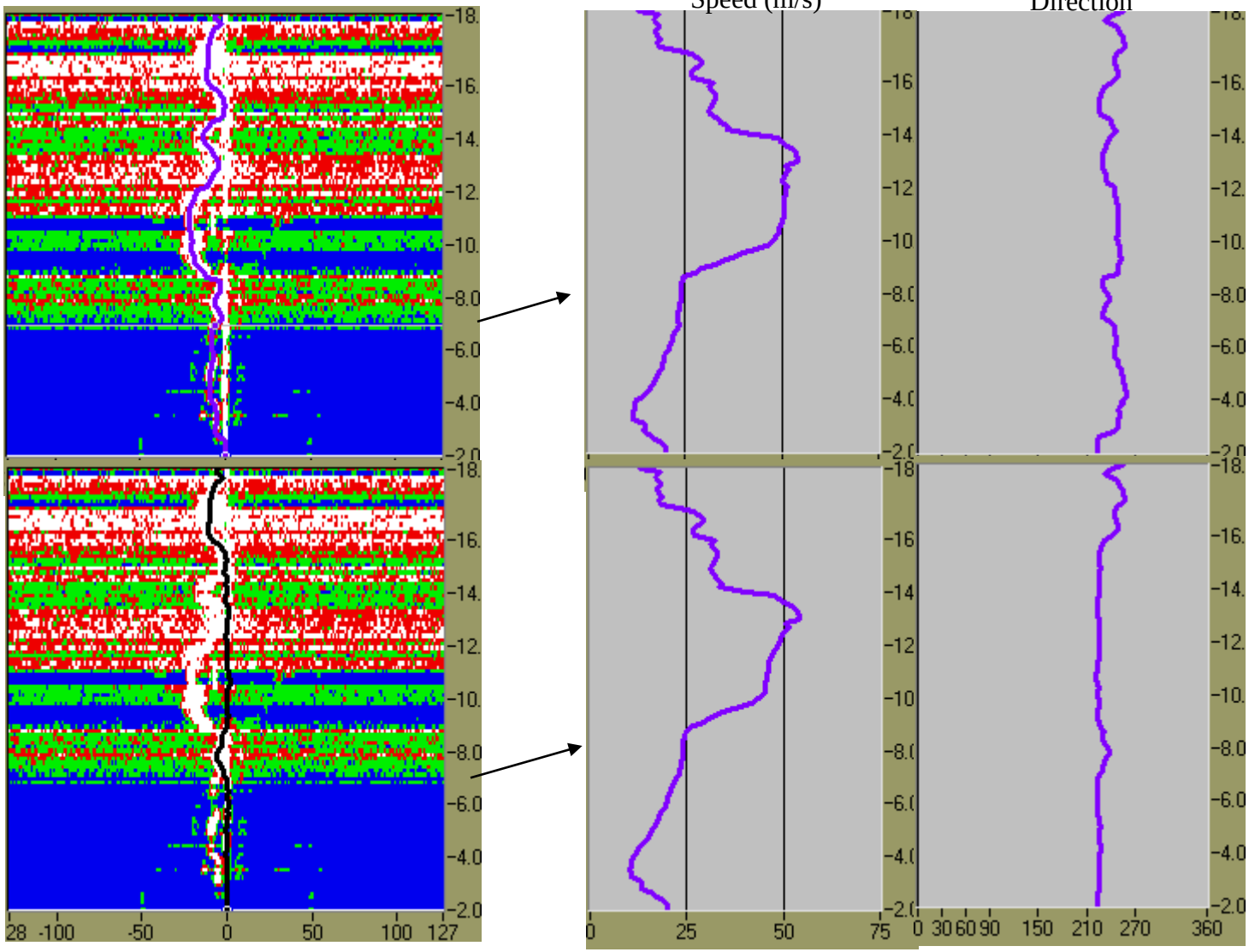


2. Release wind profile for distribution to data users **OR** inform end users of the altitude ranges where wind estimates are incorrect.



3. Modify first-guess velocity, first-guess window, or integration window as necessary for ***subsequent*** radar cycles' processing.
4. Continue with Step 1.

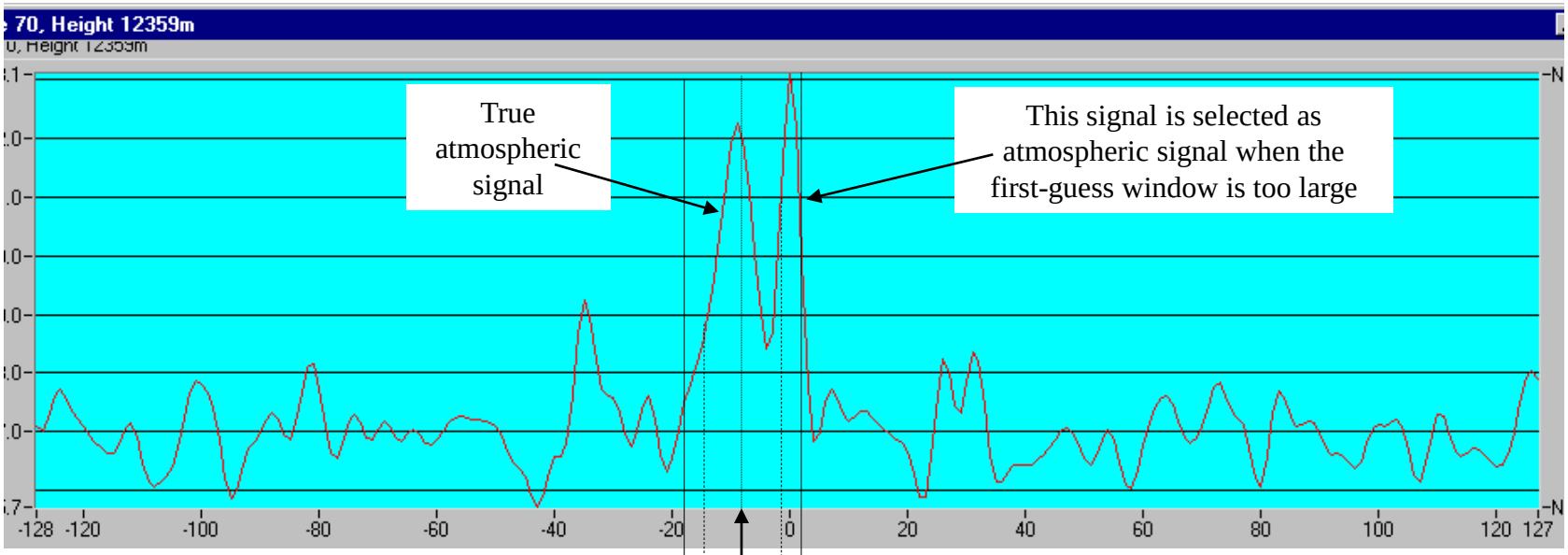
Quality Control Effects



QC is NOT a wind shear judgement call!

First-Guess Velocity and Window.

- First-guess velocity centers the first-guess window.
- Signal with “highest” amplitude within window selected as atmospheric signal



FG Window = 20 frequency bins

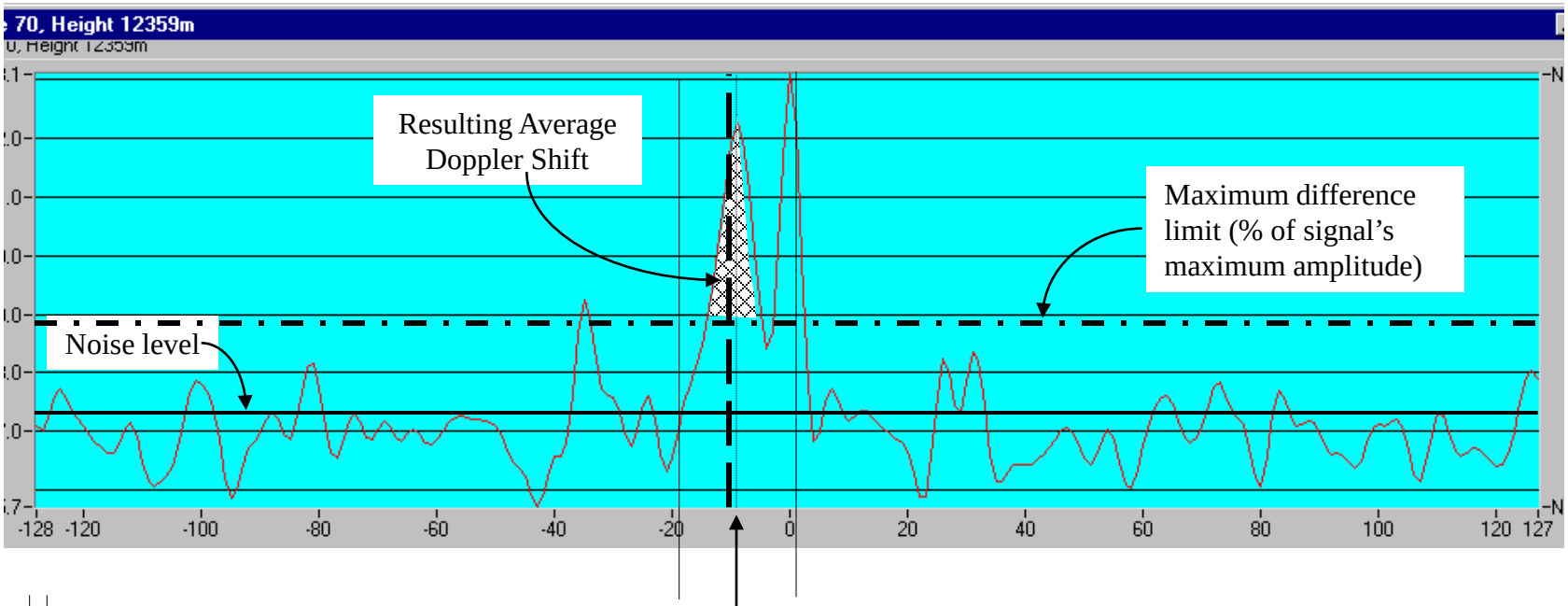
FG Window = 12 frequency bins

First-Guess Velocity

Operator intervention is required to exclude 0-Doppler shift signal from the atmospheric signal selection process. First-guess window must be reduced.

Integration Window

- Signal with “highest” amplitude within first-guess window is center of integration window.
- Average Doppler Shift is weighted average of frequency shifts within integration window.



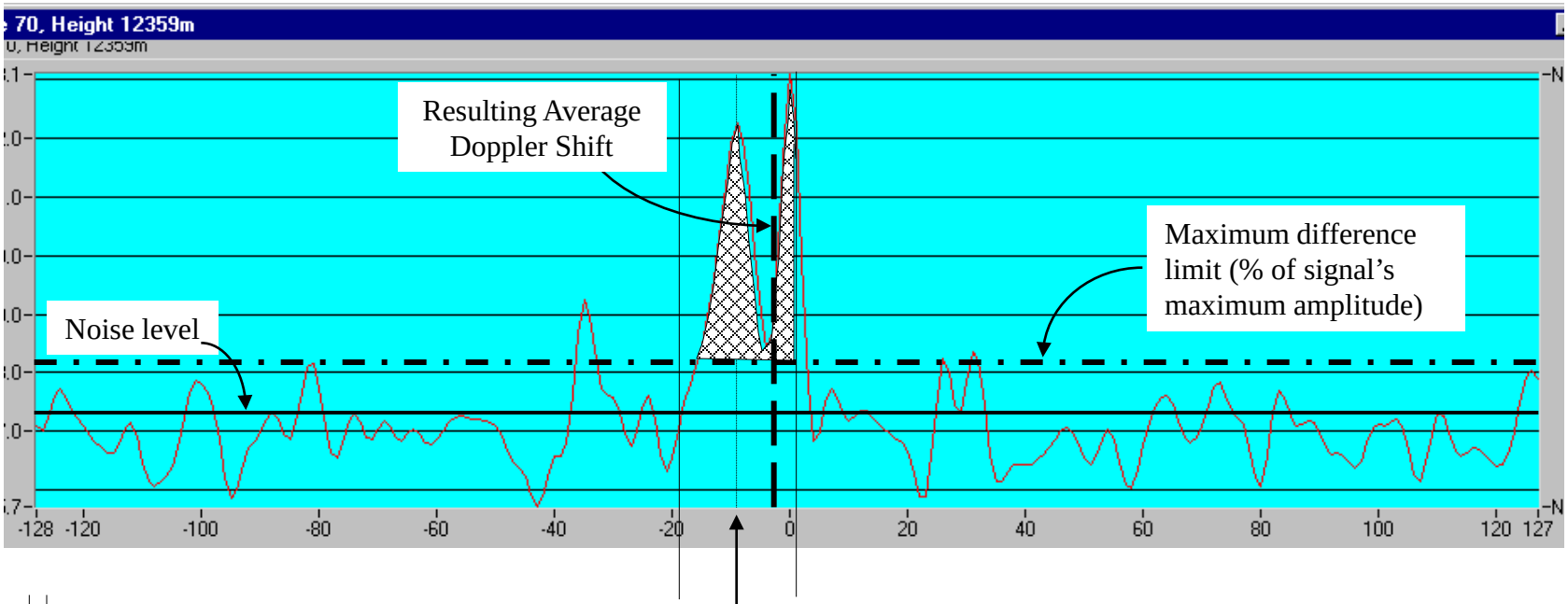
Operator-defined Integration Window = 20

Area integrated for signal power and average Doppler Shift Calculation

Center of Integration Window.

Note: Even though two signals exist within operator-defined integration window, no manual intervention required because MFFG uses most restrictive window for integration

Integration Window



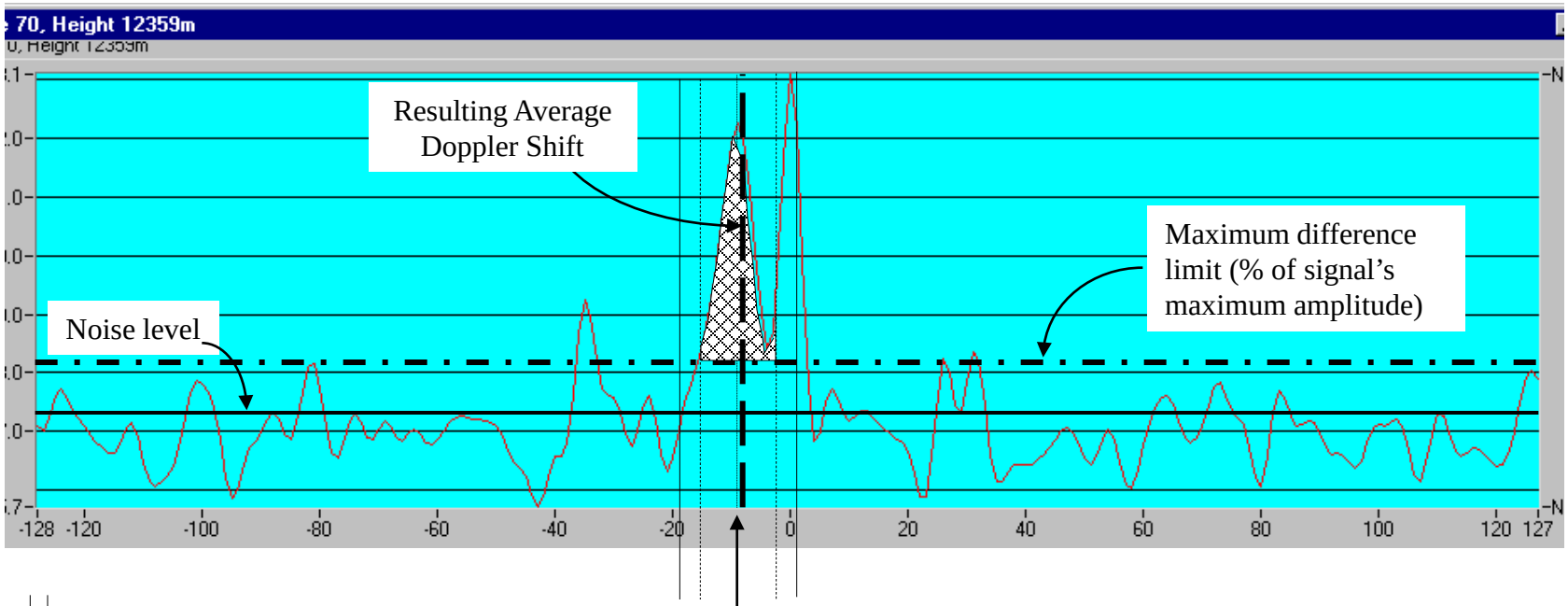
Operator-defined Integration Window = 20

Area integrated for signal power and average Doppler Shift Calculation

Center of Integration Window.

In this case the two signals existing within operator-defined integration window are included in the integration because the maximum difference limit (not an operator parameter) falls below the local minimum between the two signals. **Integration window width intervention is required**.

Integration Window



Operator-defined Integration Window = 20

Operator-defined Integration Window = 12

Center of Integration Window.

Area integrated for signal power and average Doppler Shift Calculation

The narrower integration window excludes the 0-Doppler shift signal from the integration performed as part of the signal power and average Doppler shift calculation.