

# HIRAD Instrument Calibration and Brightness Temperature Image Accuracy, Precision and Resolution



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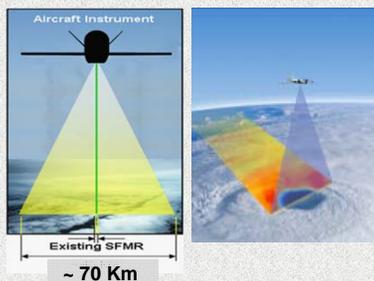


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## Hurricane Imaging Radiometer (HIRAD)

### HIRAD utilizes NASA Instrument Incubator Technology:

- Provides unique observations of sea surface wind, temp and rain
- Advances understanding & prediction of hurricane intensity
- Expands Stepped Frequency Microwave Radiometer capabilities
- Uses synthetic thinned array and RFI mitigation technology of Lightweight Rain Radiometer (NASA Instrument Incubator)



### Passive Microwave C-Band Radiometer

with freq: 4, 5, 6 & 6.6 GHz:

- **Version 1:** H-pol for ocean wind speed,
- **Version 2:** dual-pol for ocean wind vectors

### Performance Characteristics:

- Earth Incidence angle: 0° to 58-72° (see table at right)
- Spatial Resolution: 2-5 km,
- Swath: ~70 km for 20 km altitude

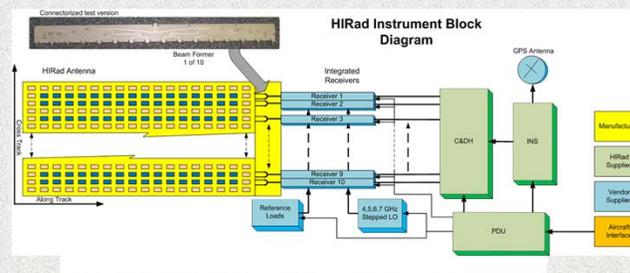
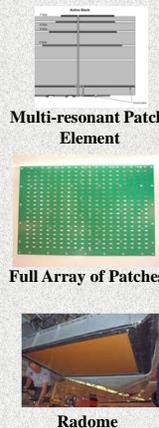
### Observational Goals:

WS 10 - >85 m/s RR 5 - > 100 mm/hr

Frequency	Beamwidth (deg) nadir / 60 deg	NEΔT (K) nadir / 60 deg	Swath (deg) [NSF<10]
4 GHz	2.6 / 6.0	0.9 / 1.1	+/- 72
5 GHz	2.6 / 5.7	1.0 / 1.1	+/- 67
6 GHz	2.6 / 5.4	0.4 / 0.5	+/- 74
6.6 GHz	2.6 / 5.2	1.3 / 2.0	+/- 58

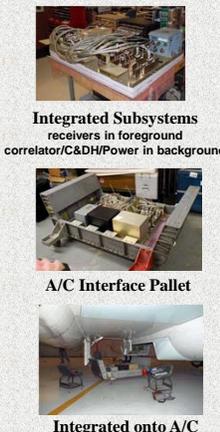
## HIRAD System Design and Subsystem Elements

### Antenna Subsystem



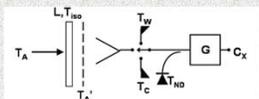
**Functional Block Diagram**  
Multi-resonant antenna array (left)  
Parallel receiver bank (center)  
Correlator/Data handling/Power (right)

### A/C Integration



## Instrument Forward Model and Calibration Algorithm

### Self-Correlation (V<sub>0</sub>)

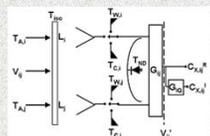


$$V_0 = T_A = [T_A' - (1-L)T_{atm}]L^{-1}$$

$$T_A' = T_W - dT_{RX} - (C_W - C_A)G$$

$$G = (T_W - T_C)/(C_W - C_C)$$

### Cross-Correlation (V<sub>n</sub>, n>0)

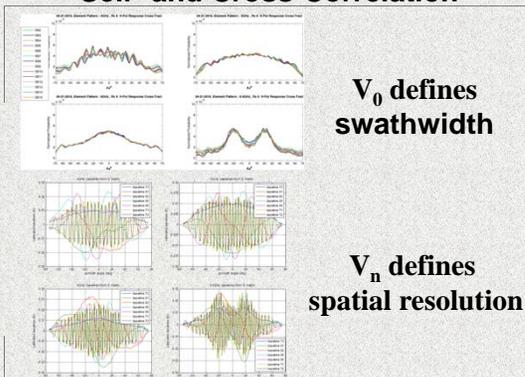


$$V_{ij}^R = (C_{A,ij}^R - C_{0,ij}^R)G_{ij}L_{ij}^{-1}$$

$$V_{ij}^I = (C_{A,ij}^I - C_{0,ij}^I)G_{ij}L_{ij}^{-1}$$

$$G_{ij} = (G_i G_j)^{1/2} \text{ and } L_{ij} = (L_i L_j)^{1/2}$$

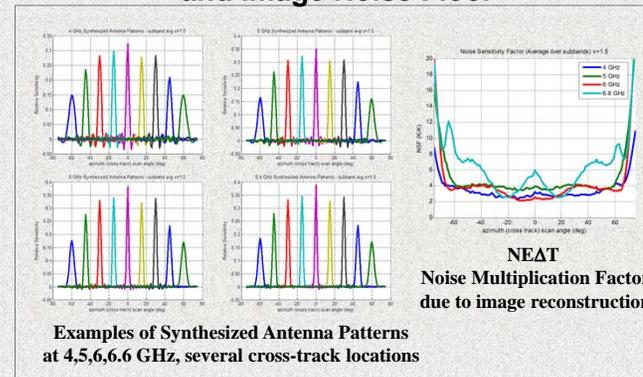
## Anechoic Chamber Measurements Self- and Cross-Correlation



V<sub>0</sub> defines swathwidth

V<sub>n</sub> defines spatial resolution

## Synthesized Antenna Patterns and Image Noise Floor



Examples of Synthesized Antenna Patterns at 4,5,6,6.6 GHz, several cross-track locations

NEAT  
Noise Multiplication Factor due to image reconstruction