

Profiling Airborne Microwave Radiometer

New & improved radiometer for atmospheric observations



DOE SBIR Phase II Project: DE-SC0015068

Project Title: Profiling Airborne Microwave Radiometer - PAMR

Boulder Environmental Sciences and Technology

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Boulder Environmental Sciences and Technology is developing a new airborne microwave radiometer for atmospheric and cloud observations. The Profiling Airborne Microwave Radiometer (PAMR) is built for emerging observational platforms such as aerial drones, or Aerial Systems (UAS). The compact size of the PAMR radiometer receivers is also suitable for nano satellites (NanoSats, CubeSats) and for remotely located observations, e.g. from buoys or a mountain top. These applications require a new approach to radiometer design, with an emphasis on small, integrated, low power radiometer units that provide robust and reliable performance at an affordable price.

PAMR diameter is 100 mm and its overall length, with three dual polarization radiometers, is 592 mm. The instrument mass is ~4.6 kg and overall power consumption is less than ~35 W. The scanning part of the instrument rotates at 2 rotations per second. PAMR observes the atmosphere in a plane perpendicular to the flight path.

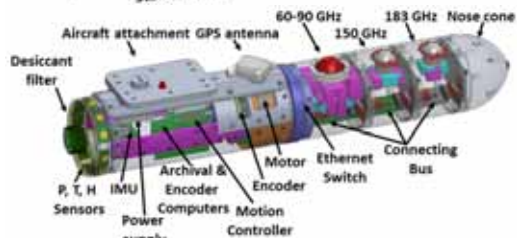
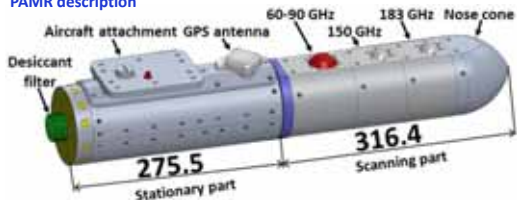
PAMR is built for autonomous operation, and only power is required from an aircraft. It is a modular instrument, with each radiometer module on the bus, and could be thus quickly and easily disconnected and removed or replaced. No temperature or pressure stabilization is required.

PAMR outputs are calibrated brightness temperatures. Derived parameters are:

- Temperature profile
- Humidity profile
- Integrated water vapor
- Integrated cloud liquid content
- Cloud phase (ice/liquid) information
- Mean particle size

PAMR is less costly and more informative than radiosondes!

PAMR description



Overall size: 592 mm, 100 mm diameter
 Mass: 4.6 kg
 Power consumption: ~35 Watts
 Operational temperature range: -40°C to +50°C
 Maximum operating altitude: 12 km

DOE ARM ArcticShark UAS is an ideal platform for the PAMR operation.



PAMR radiometer modules

PAMR is a modular instrument, each module operates on its own and it requires only power and an internal Ethernet connection. Each module has its own data acquisition system and power supply. Thus many atmospheric sensors could be modified to fit into the PAMR configuration.

Available PAMR configuration:

PAMR configurations	Weight (grams)	Power (mW)
PAMR Frame	3,398	19,780
60-90 GHz module	592	4,600
150 GHz module	275	4,500
183 GHz module	322	4,500
Total	4,587	33,380

The Stationary part of the PAMR provides:

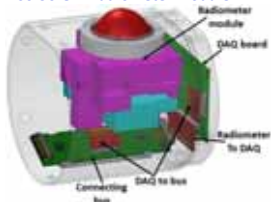
- Mechanical attachment to the aircraft
- Desiccant filter
- Communication interface to the aircraft (Ethernet connection)
- Archival of radiometer data
- Some limited on-board processing
- Ambient environmental variable measurements - pressure, temperature, humidity
- GPS/position data acquisition
- Attitude measurements - pitch, roll, heading
- Housekeeping data acquisition and archival

60-90 GHz Radiometer module

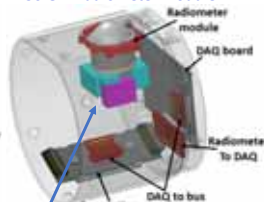
Primarily for temperature profiling, cloud water content and particle size retrieval
 Nine channels, all dual polarization

Channel center frequency (GHz)	Bandwidth (MHz)	Sensitivity (K)
60.37	220	0.46
61.485	470	0.31
63.875	450	0.32
64.42	500	0.30
65.77	1020	0.21
67.10	1500	0.17
80.00	2000	0.15
85	2000	0.15
89	2000	0.15

60-90 GHz radiometer module

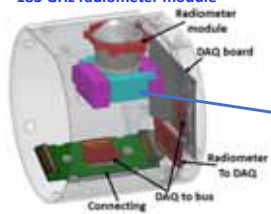


150 GHz radiometer module



150 GHz radiometer
 Dual polarization, two channels
 Cloud composition
 Water vapor content

183 GHz radiometer module



183 GHz radiometer
 Dual polarization, five channels
 Cloud composition
 Water vapor profiles1

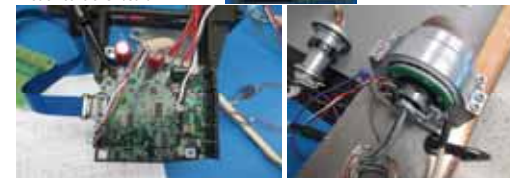
Work in progress

- We are developing:
- Components for radiometer receivers
- Data acquisition system
- Ethernet Switch
- Motion system
- A stand for ground based operations
- Antennas

Data Acquisition Board

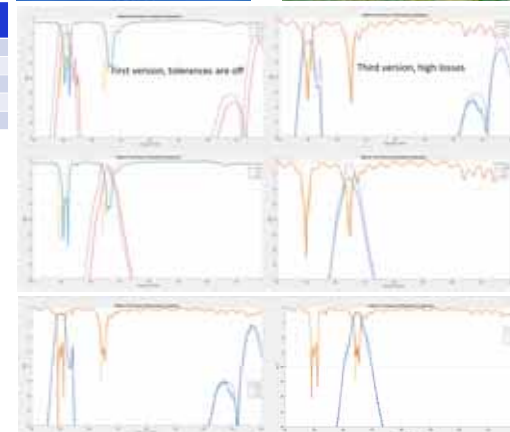


Motion controller board



150 GHz radiometer diplexer

A filter, one input, two outputs



Marine Profiling Radiometer

- A buoy based radiometer
- Temperature profiles
- Humidity profiles
- Cloud parameters
- Most reliable marine boundary atmospheric layer profiling

