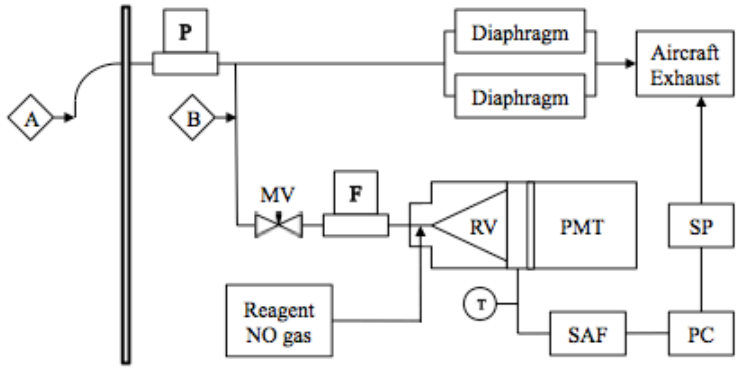
HAIS Fast Ozone Development

Development Goals	Result
FAA approved NO containment and delivery system	Completed in 2006
sub-ppbv detection limit	0.1 ppbv detection limit demonstrated in lab, flight tests 2006-2008
5-hz frequency response	demonstrated in lab tests completed in FY2009

Performance	1 Hz,	5 Hz,
	Δt = 1 sec	Δt = 0.2 sec
Sample flow (sccm, cm^3/min at 0ºC, 1 atm)	500	
Reaction Vessel Pressure (torr)	10	
Reaction Vessel Temperature (ºC)	35	
Pure NO Flow (sccm)	2	
Background counts per Δt	200	40
Sensitivity, counts per Δt per ppbv	2200	440
Signal to Noise Ratio at 20 ppbv O_3	1550	690
Signal to Noise Ratio at 100 ppbv O_3	7770	3475
Smallest Δ in mixing ratio (ppbv) at 20 ppbv O_3	0.10	0.21
Smallest Δ in mixing ratio (ppbv) at 100 ppbv O_3	0.21	0.48

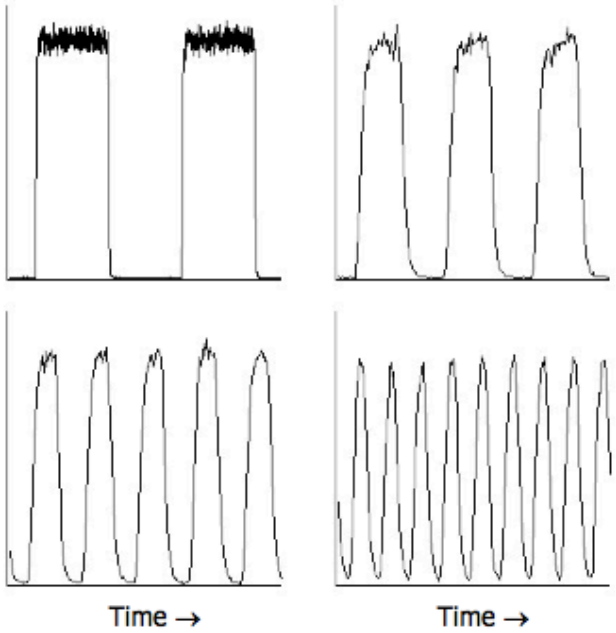


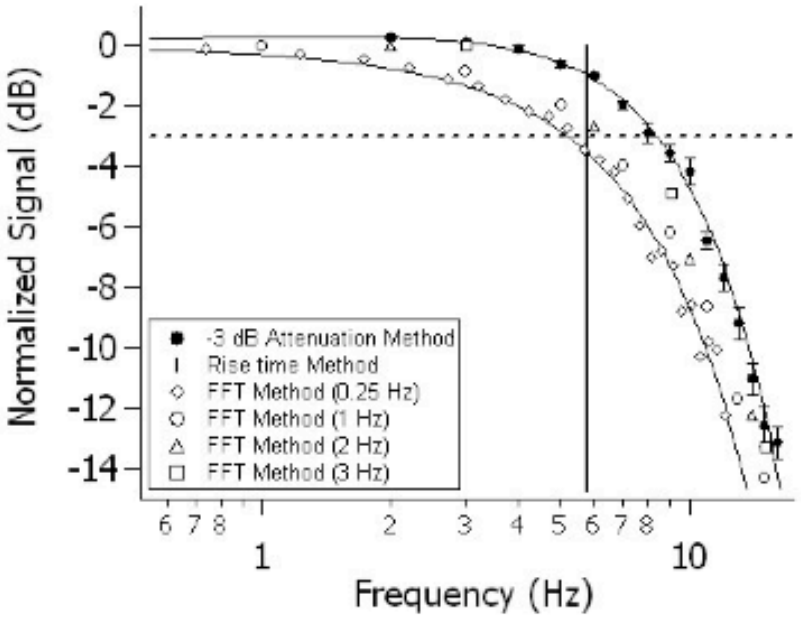
Lab measurements of frequency response.

f_H = high frequency cutoff, 10-90% rise time method

$f_{-3\ dB}$ = -3 dB attenuation point upon increasing solenoid valve switching frequency from 0.25 – 20 Hz in 1 Hz steps

Inlet Pressure (Torr)	t_r (sec)	f_H	$f_{-3\ dB}$
570	0.08	4.4	5
400	0.07	5.0	6
300	0.065	5.4	6
200	0.055	6.4	7


Time →
Time →


Normalized Signal (dB)
0
-2
-4
-6
-8
-10
-12
-14
-3 dB Attenuation Method
Rise time Method
FFT Method (0.25 Hz)
FFT Method (1 Hz)
FFT Method (2 Hz)
FFT Method (3 Hz)
6 7 8
1
2
3
4
5 6 7 8
10
Frequency (Hz)

Interface to RAF groups
Aeronautical Engineering: structural and mechanical designs have been completed, approved for both stand-alone and 4-channel operation on G-V; near-term future installations should require only limited modifications to certification package documents.
Instrumentation group: Electrical certification package similarly established and unlikely to undergo significant modification.
Software interface: Variable names and metadata attributes have been established. RAF field and preliminary quality netCDF data files contain high-quality real-time data, adequate for preliminary science analyses. CARI conducts final processing. A mechanism has been established to hand off merging tasks to EOL data managers.
Project management: Our feasibility input is already incorporated into the RAF and EOL global processes. Project managers include our stated needs into their planning activities. Communication with PIs usually proceeds through the PM acting as primary point of contact.

Future goals
Acquire spares (started already. FY08: purchased NO CV spares; FY09: purchased 3 of 4 data system cards. Unmet needs: reaction vessel, pump, and key T, P, and flow control components).
Incorporate water correction equation into nimbus quick look product . Real-time product then becomes 'near final' quality. (H2O correction ≤10%)
Long term: Duplicate instrument to allow efficient simultaneous 2-aircraft measurement support. (When not supporting simultaneous NASA experiments, we have this capability now.)
Long-term: Educate technicians, flight scientists/coordinators to eliminate the need for onboard operator (warning beacon interpreter)
Long-term: Re-design reaction cell housing to improve thermal isolation, increase dry ice lifetime.
Long-term: miniaturize components to reduce size, weight. : Look for ways to replace inlet manifold pumps with passive pumping mechanism (e.g. venturi)
Look for technological advances that create an opportunity to eliminate the need for dry ice coolant
Caution: At current level of CARI activity, it is just possible to fully staff 3-5 projects per year. However, as the list of CARI-supported instruments grows, a need for increased staffing resources is acknowledged.