

Airborne Research Instrumentation Testing Opportunity (ARISTO)

A proposal for an annual NSF/NCAR Aircraft Flight Test Program

29 August 2014

Background

To maintain cutting-edge and vibrant airborne NSF-supported research, the development of new instrumentation and improvements to existing instrumentation are crucial. However, instruments that operate in an airborne environment generally require extensive and repeated flight-testing to determine performance and data quality prior to a field deployment. Ongoing upgrades to mission tools and platform infrastructure such as data systems, satellite communication systems, inlets, and software also benefit from periodic testing to verify performance and ensure reliability well ahead of a campaign.

Despite these critical testing needs, flight opportunities are limited, especially for university investigators but also for EOL. Episodic flight-testing to meet both community and EOL needs has been successfully performed in the past, through individual proposals for intensive test periods (under the Instrument Development and Education in Airborne Sciences (IDEAS) program) and as part of project-specific test programs (e.g., DC3-Test, SAANGRIA-Test). A very limited number of test flight hours, usually 10 hours spread across two flights, are also routinely scheduled as part of a payload installation prior to the start of a field deployment. Project-specific tests are usually restricted to instrumentation essential to and scheduled for participation in an actual campaign, and therefore not open to the wider user community.

Instrumentation development teams within the NSF community and EOL would considerably benefit from regularly scheduled flight-testing programs, as these tests help increase and improve LAOF airborne capabilities. Thus, EOL recommends the creation of the **Airborne Research Instrumentation Testing Opportunity (ARISTO)**, an annual airborne instrumentation testing program on the NSF/NCAR aircraft as described below.

Purpose of ARISTO Test Flights

The purpose of the ARISTO test flights is fundamentally different from test flights immediately before a normal LAOF aircraft deployment. Test flights ahead of a field campaign are used to verify the installation of an existent instrument, e.g., checking for leaks, vibration, and cable functionality. Such test flights are usually covered in a one to two week time period. The ARISTO test flights are intended for testing of newly developed or highly modified instruments as part of their development efforts. Therefore, much more time is planned between flights to allow for further modifications to the instrument. Furthermore, whereas project test flights are usually conducted in the vicinity of RAF's home base, ARISTO test flights may need to extend further, both in distance and time depending on the particulars of a new instrument. Satisfying such requirements calls for a longer test flight period and more test flight hours than are required for installation test flights before a normal aircraft deployment.

Eligibility and Requirements

All instrument developers/investigators with existing NSF funds related to instrumentation are eligible to apply for access to the NSF/NCAR aircraft for this instrumentation testing. Investigators selected for an ARISTO test flight period are required to provide appropriate details on their instrument (see Appendix I) and comply with all EOL/RAF certification requirements.

The ARISTO program is not intended to provide flight opportunities for commercial instrument builders or for the collection of proprietary data for commercial instrument development. Exceptions may be made if the flight test purpose is to evaluate instrument performance for its possible purchase and addition to the LAOF

capabilities. While test flight opportunities could be opened to investigators with instrument developments funded by non-NSF US agencies, those arrangements would be negotiated between the NSF Program Director for LAOF and the responsible Program Officers.

Instrument Test Priorities

Proposals will be ranked and instruments will be selected for testing based upon the following prioritized criteria:

- Priority 1: Instrumentation that is essential to a funded or proposed NSF field campaign but that has yet to be test flown and certified for an NSF/NCAR aircraft.
- Priority 2: Instrumentation that has recently been developed or is being modified as part of a funded NSF grant or cooperative agreement.
- Priority 3: Instrumentation that has a high likelihood of being routinely used by the NSF community in future field campaigns.
- Priority 4: Instrumentation that has a high likelihood of being ready for flight-testing and complies with all EOL/RAF certification guidelines.
- Priority 5: Instrumentation that is of high relevance to unmet needs in the LAOF and/or in the US airborne research fleet.

Process, Implementation and Approval

The ARISTO program will be scheduled annually at the beginning of each calendar year (January/February), approximately 12 to 18 months ahead of each ARISTO test flight period so not to interfere with funded scientific field campaigns, to permit for testing during different seasons, and to allow for sufficient time for advertisement and preparation. At the time of the scheduling, EOL will determine the NSF/NCAR aircraft to be used for the test program. While the availability of the aircraft will be primarily driven by the schedule of funded airborne research campaigns, EOL will try to alternate between the GV and C-130 to accommodate a wide range of instrumentation. If both aircraft are available in a given year, the final decision will be made based on the requests received.

Once the schedule is set, EOL will prominently post an announcement for the ARISTO test flight period on its website and will include a clear deadline for submission. The program will also be included in the LAOF project "Queue" and EOL will send an email to several email lists (NSF/AGS, EOL and UCAR) to reach PIs and instrumentation developers.

Requests for instrument testing can be submitted throughout the year via a simple online form (see Appendix I) up to six months before the start of each ARISTO test flight period. Instrument developers are strongly encouraged to notify EOL of their interest in participating in the ARISTO program as early as possible even if the instrument is in the early stages of development. Once the deadline has passed, EOL will require one month to assess received requests and develop a preliminary feasibility analysis, which will include EOL's suggested instrument combinations and payloads that could satisfy the various testing needs described above; a recommended number of flight hours and flights to accomplish testing objectives; and a budget (see Funding below).

Requests, instrument priorities and suggested payloads will be assessed by the NCAR-led ARISTO Review Panel, a small team of experienced airborne instrumentation scientists with representation from NCAR, the university community, and NSF. The membership of the panel will be determined by NCAR/EOL in consultation with the NSF Program Director for LAOF. The panel will convene virtually within six weeks after the submission deadline to evaluate EOL's feasibility analysis and suggested aircraft payload, and if necessary, recommend changes

based on the above stated priorities. After the panel review, EOL will forward each ARISTO test flight period request to the NSF Program Director for LAOF for final approval. It is assumed that NSF will make a final decision within two weeks of receiving the request by EOL.

Following NSF approval, an EOL project manager will be assigned to lead the year's ARISTO test flight period. The EOL project manager will communicate the NSF decision to the individual instrument PIs and develop the detailed schedules, timelines, and flight plans with their input. Once all technical information is received by EOL, RAF's aeronautical engineering staff will prepare the necessary FAA documentation and submit it in preparation for each test flight period. Four to six weeks will be needed for payload installation ahead of each ARISTO test flight period.

Flight Hours and Scheduling

EOL estimates that approximately 15 flight hours would be required for instrument testing conducted from the EOL/RAF home base in Broomfield, CO in a given year. EOL anticipates several shorter (2-3 hour) and one longer (6-8 hour) duration flight as part of each ARISTO test flight period to not only test instrumentation at various altitudes and speed ranges but also in different environments as needed. We also assume that there will be several days between flights to address any issues that were discovered during each test flight. As a result, ARISTO test flight periods will last approximately three to four weeks excluding upload periods. We are aware that external instrument providers may not have the time or resources to participate for such extended periods of time. We will work with each individual to make sure that, if needed, their testing needs can be successfully met in a shorter time frame, including an option to either remove the instrument from the aircraft and leave early or return to the EOL/RAF base at the completion of the project for instrument removal.

Requests for more than 20 flight hours and for deployment covering more than a single overnight stay to locations other than the EOL/RAF home base in Broomfield, CO will be treated as a regular facility request, i.e., will have to go through the standard OFAP process on the same timeline as other small/simple requests. In years when instrumentation-testing requests are deemed insufficient by NSF, EOL and/or the ARISTO Review Panel to justify a flight test program, or when scheduling conflicts with approved field projects cannot be resolved, the flight test requests received will be rolled over into the following year.

Funding

The ARISTO program would be funded through the NSF Deployment Pool. We propose to allocate no more than \$150K per year for each ARISTO test flight period; this is similar to the funding mechanism for educational deployment requests. Allocations for each ARISTO test flight period will be based on a cost estimate provided by EOL to NSF as part of the request.

NCAR/EOL will support each ARISTO test flight period through its base funding as is done for regular field campaigns. Funding from the Deployment Pool will cover basic aircraft operations costs (e.g., AMR, fuel, satellite communications etc.) and DFS charges associated with the installation of instruments. Instrument providers are expected to cover all expenses related to their own staff and travel, and costs associated with the operation of the instrument (e.g., expendables).

Appendix I

Point of Contact (<i>name, institution, email, phone number</i>)
Please describe your instrumentation
Which NSF/NCAR aircraft is your preferred testing platform?
How many test flight hours/flights, dedicated to your instrument, are you requesting?
Please describe your instrument testing needs (<i>e.g., altitude requirements, special maneuvers, additional measurements for evaluation of system performance, airspeed requirements/ limitations</i>)
Please describe the meteorological and/or target conditions needed for testing (<i>e.g., need for polluted/unpolluted air, target location and airmass type</i>)
What are the dates that your instrument will be available for testing?
How many people will be needed to test the instrument on site, and what are their roles?
Are there any export restrictions on your instrument or proprietary restrictions on the instrument or data?
Has the instrument previously flown on either the NSF/NCAR GV or C-130? If yes, (i) when was it last flown, and (ii) have any weight, structural, electrical, wiring or optical changes been made, which would require re-certification?

Please provide the following information for each instrument to be tested:

Instrument Name (<i>spell out acronyms</i>):	
Individual weight of all components:	
Complete size dimensions of all components:	
Rack-mountable 19" panel space required (Note: depth beyond 25" will overhang in back):	
Are you supplying your own 19" rack? (Note: racks must survive 9G crash load.)	yes/no
Hazardous material required:	
Radioactive sources or materials:	
Power required (watts, volts, amps):	
Type of power (DC, 60 Hz, 400 Hz):	
What is the maximum operating (cabin) temperature at which the instrument will function as intended?"	
External sensor location (if any):	
Are signal(s) to be recorded on RAF's Aircraft Data System?	yes / no
If yes: Signal format (digital, analog, serial):	
Full-scale Voltage:	
Range:	
Resolution:	
Sample Rate (1, 5, 250 sps):	
Do you need real-time, in-flight, RAF-measurement, serial data feed (RS-232, RS422)?	yes / no
Need IRIG time-code feed?	yes / no
Special sensor calibration service required?	yes / no
Need full-time operator during flight?	yes / no
Number of laptop computers for on-board use:	
Will EOL support be required in preparing the instrument(s) for use on the aircraft (other than inspection, installation and power hook-up)?	yes / no

If yes: specify type and lead time	
Will you be using your own recording system?	yes / no
What additional recording capability is needed? Please provide details on the number of signals, their characteristics, format, synchronous, fire-wire, ethernet, etc.	
If nonstandard output formats and/or data rates are required, how often are the measurements needed? <i>Note: The standard format for processed, RAF output data is net CDF data available for download.</i>	

Please provide the payload ground support needs for user-supplied instrumentation:

	Preflight needs	Postflight needs	Routine Maintenance
	On flight days	On flight days	On non-flight days
Access (hrs)			
Power (hrs)			
Special support needs			