# ARC Array Development Test Sweeping Jet Actuator Research

## Test Status Update – March 31, 2017

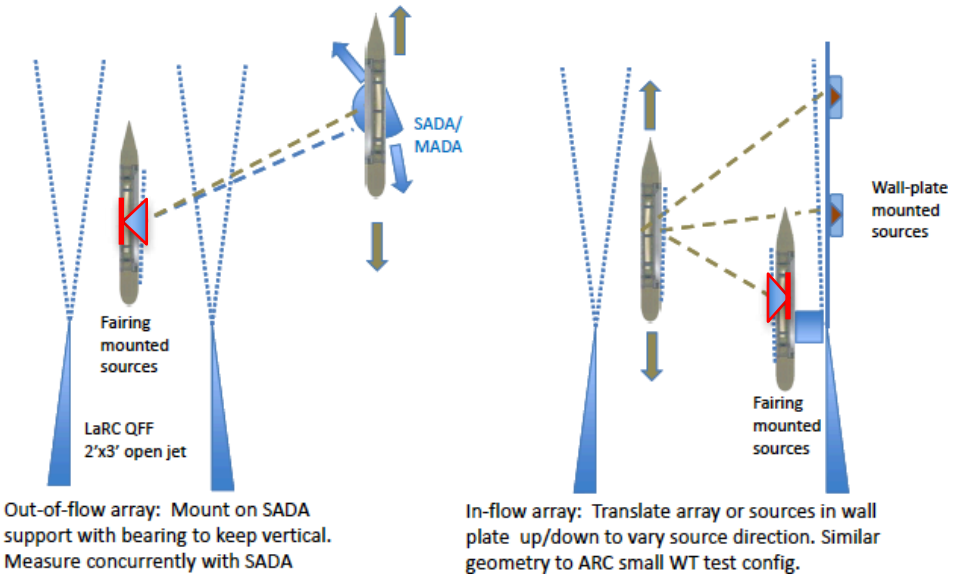
Clifton Horne, Nate Burnside
Experimental Aerophysics Branch (AOX-FML)

# ARC Array Fairing

- Array pattern ~ 8”D available patterns –
  - ARC – 3 arm spiral (24/25 mics),
  - LaRC-SADA radial 33 mics
- Fairing – 21” L x 14” W x 2”T
- Additional array fairings, plates built for GRC, LaRC
- 15 CGS Rayl Kevlar screen replaced with s. steel cloth (2.9 Rayl, 325x325 mesh – Podboy) for reduced reverberation and BL scrubbing noise

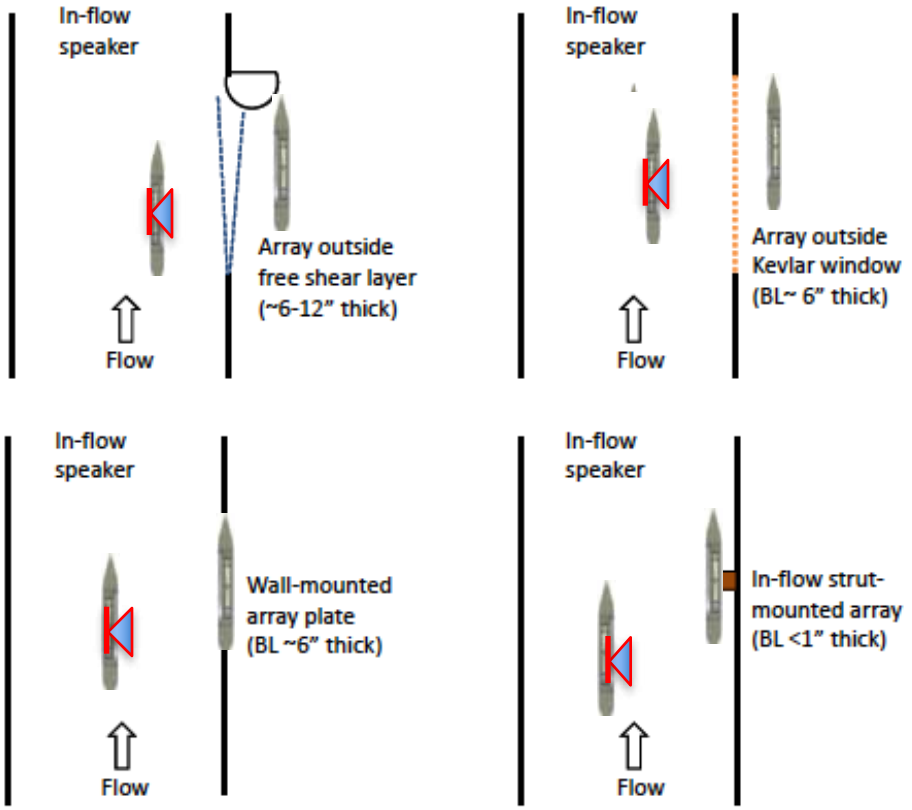
# In-Flow Reference Array/Sources

**Objective:** Using in-flow arrays, measure radiated noise levels over 1<f<50 kHz to 0.5 dB ( 6%) accuracy with 10-20 dB suppression of background/reverberant for test section speeds up to M = 0.25




Out-of-flow array: Mount on SADA support with bearing to keep vertical. Measure concurrently with SADA

In-flow array: Translate array or sources in wall plate up/down to vary source direction. Similar geometry to ARC small WT test config.




LaRC QFF 3' x 2' open jet tunnel with wall plates:

1) Compare LaRC SADA and ARC 24 element patterns

2) Compare in-flow vs out-of-flow array measurements of in-flow source

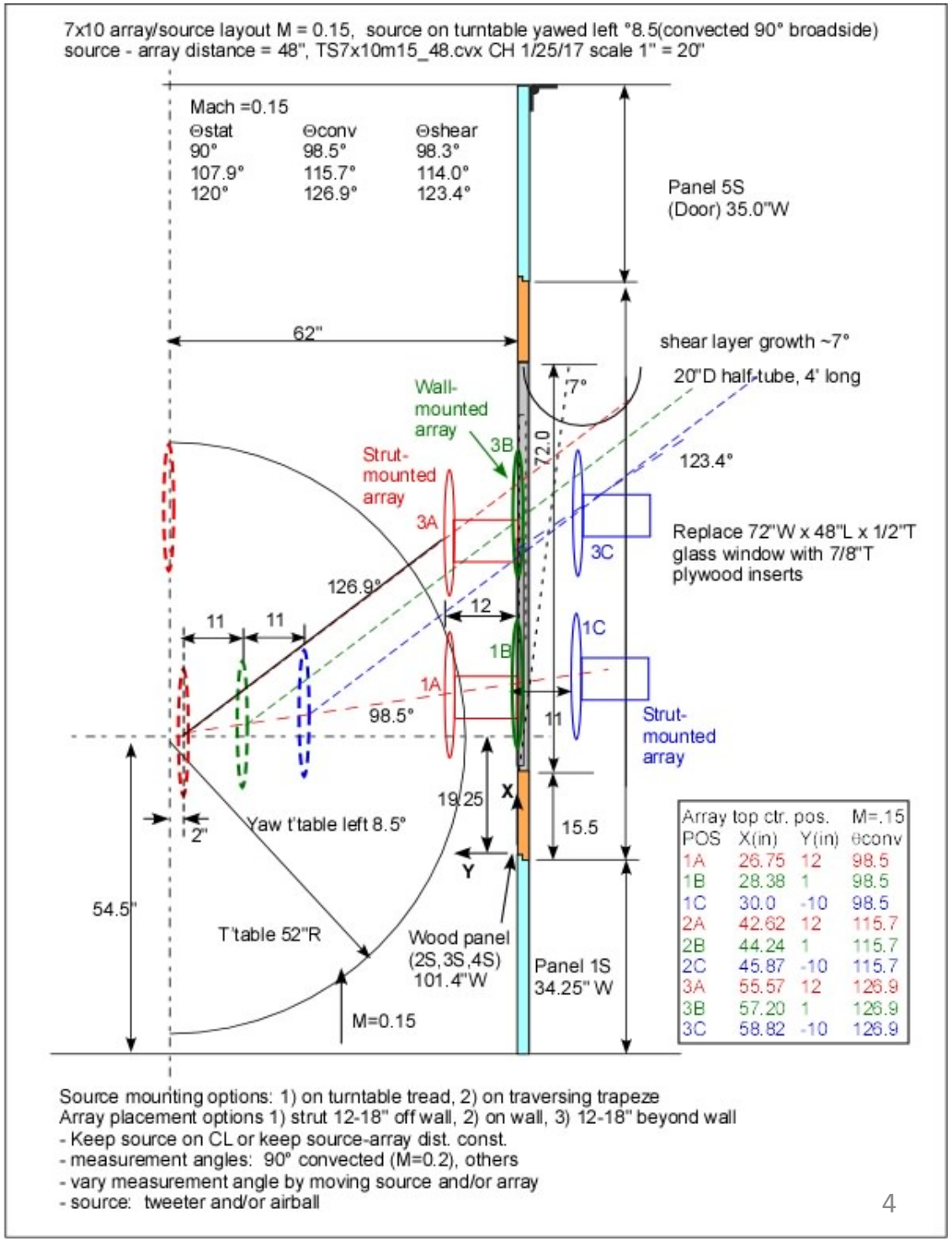
ARC 7'x10' wind tunnel:

Compare array response for 4 installations:

- in-flow : strut mount, wall mount
- Out-of-flow: open shear layer, porous screen
- Compare with similar tests at GRC

# Test section layout

- Test section geometry fixed for M = 0.15, also test M=0.25
- Yaw turntable left 8.5 deg & lock for test
- Mount source fairing on steel plate between T-frame spools
- Change source locations by removing floor cover plates and changing locations of 2 bolts.
- New collector at trailing edge of 6 ft L x 4 ft high opening for free shear layer measurement



# Strut Mount configuration

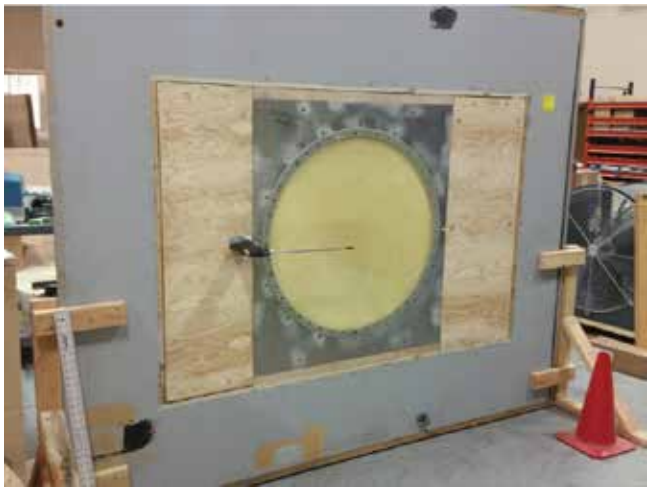
Front: array fairing 12” from wall

Back: 120 deg emission station

- 80-20-15 frame (~200 lb) independently supports array stand and probe traverse
- 3 preset stations to measure source emission angles of 90, 108 and 120 deg
- No array/strut loads to wall panel
- Flow probe removed during acoustic measurements
- array fairing being calibrated, replaced with plywood blank for these photos

# Wall and Porous Screen Config

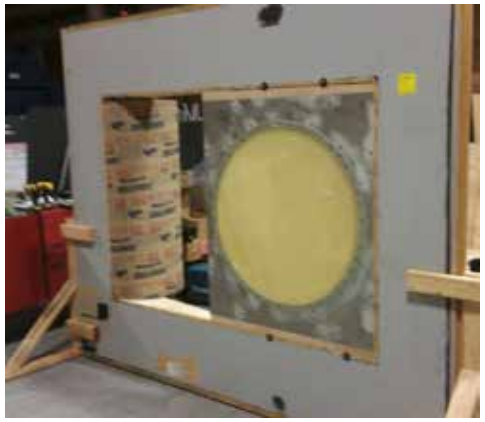
Front: Wall mount config



Front: Wall porous screen config

- Three panel configurations corresponding to emission angles of 90, 108, 120 deg
- Each panel secured in back with ¾” plywood doublers and ¼-20 screws secured to T-nuts in original wall panel
- Flow probe removed during acoustic measurements

# 6 ft L x 4 ft H Free Shear Layer Collector



- 20”D half-round collector stiffened with internal wood frame.
- Streamwise plywood flow fences top and bottom
- Plan to check out low speed attachment point with tufts and pressure diff. during initial operation

# Source Fairings

## Identical source sets, fairings at LaRC,GRC

### Directional Source (tweeters)

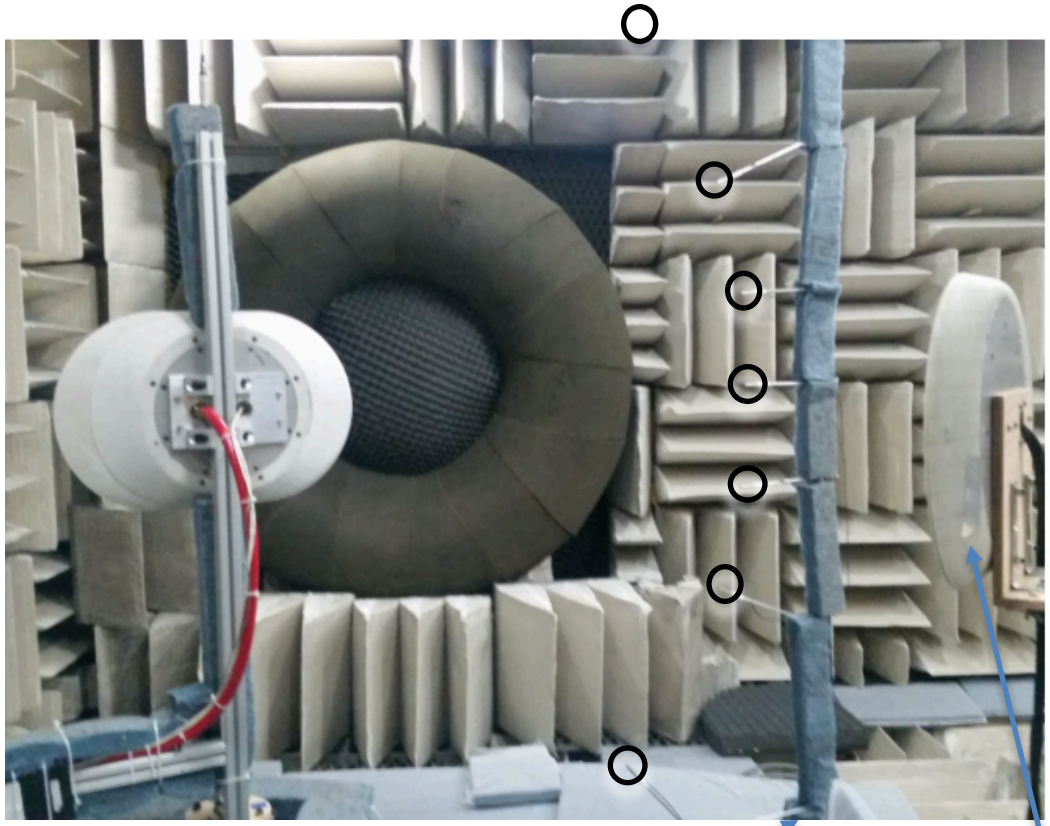
- Two gimballed tweeters, 25W 0.8-40 kHz directional output (more directional at higher frequencies)
- ARC preset to 90, 120 deg emission
- Add foam to reduce internal reflections

Both: source is in dead-air space behind windscreen, unaffected by wind. Refraction at screen interface for high M, shallow radiation angle.

### Omnidirectional Source (airball)

- 2” sphere with 44 holes 0.03” D in top half
- Temperature, pressure sensor in fairing
- Runs on shop air controlled by electronic valve. 1-50 kHz omnidirectional output
- Fairing supply pressure tested to 450 psi, reported to ARC pressure safety. Rated as open flow system.
- Optional hemispheric screen cover 2.5” D may smooth spectrum, directivity
- Foam inserts to reduce reflections

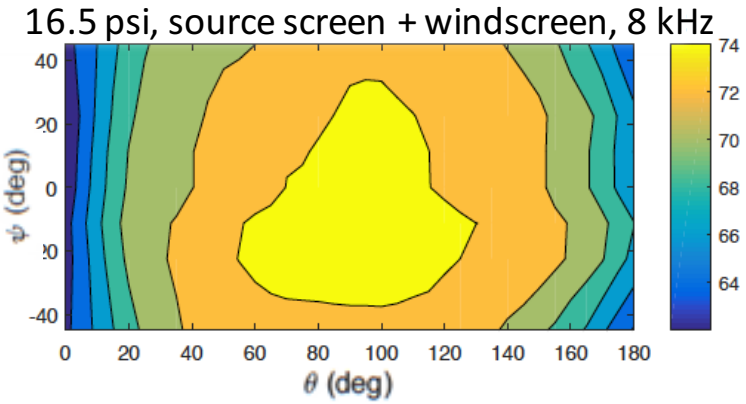
# Airball source tuning and directivity

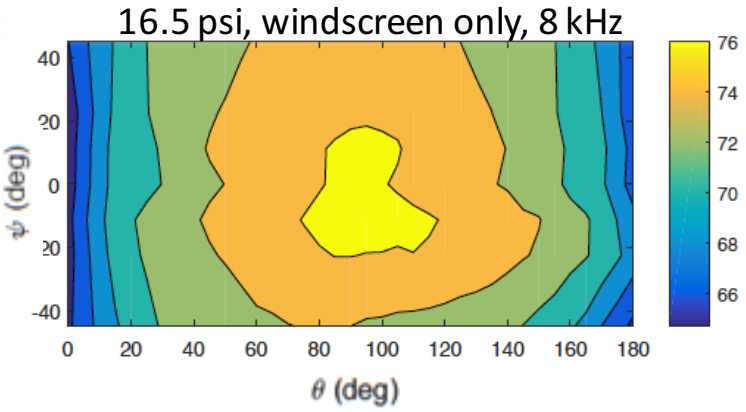


Rear of airball source fairing on turntable

Fixed microphone stand, 48” radius

Fixed array, 48” radius



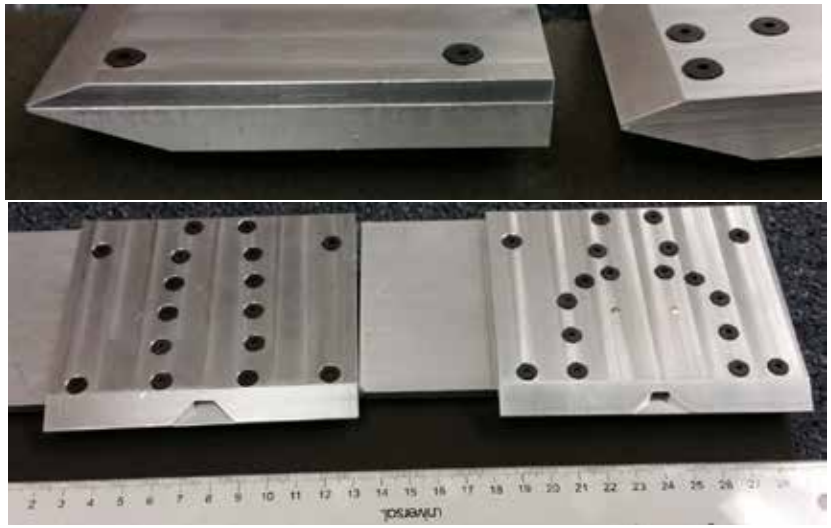




Directional maps of source level for 1/3 octave level

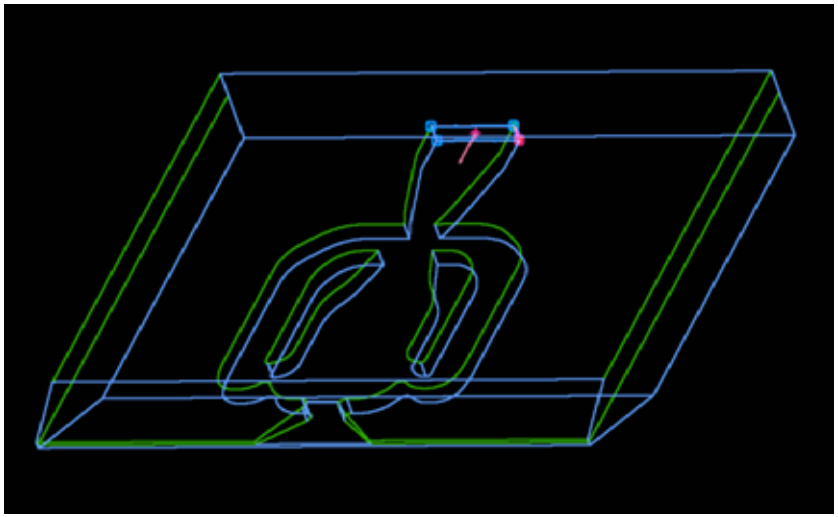
# NASA Array/Source Development Test Status

- GRC array test in progress at NATR jet facility with in-flow array, tweeter source
- ARC 4 wk test in Army 7x10 starts ~ 5/1
- LaRC QFF test scheduled for summer
- Source fairing, speaker and airball sources – fabrication complete.
- Source tuning, calibration in progress in ARC anechoic chamber

# Sweeping Jet AFC Aeroacoustic Study



Sweeping/non-sweeping actuator models with zero wall length



CAD model of sweeping jet actuator (C. Hunter)

- ARC ½ scale models of sweeping, non-sweeping jet actuators modified for ”zero” wall length to compare with CAA (Hunter)
- CAA geometry assembled from drawings, CAD files
- Directional measurements to proceed following array WT test (July-Aug)

# Summary of ARC Progress, Plans

- In-flow reference array/Sources
  - Identical fairings, array plates, tweeter and airball sources assembled; will be calibrated and tested at ARC, GRC and LaRC this year
  - ARC plans to test array response in-flow (strut, wall mount) and out-of-flow (porous screen, free shear layer) on 3 emission angles on track for 4 wk test beginning May, includes surveys of mean and turbulent boundary/shear layers for each config.
  - Further testing in FY18 desired for improved source design, effects of array pattern/size, porous wall screen material (Kevlar->s. steel), vary array penetration into free shear layer (i.e. 14x22 traversing sensor application)
- Sweeping jet actuator aeroacoustics
  - Full field acoustic survey of sweeping/non-sweeping actuators with zero wall length to compare with CAA study
  - Prepare for acoustic survey of multi-actuator configurations to support CRM AFC high-lift configuration