



Fundamental Aeronautics Program

Subsonic Rotary Wing Project

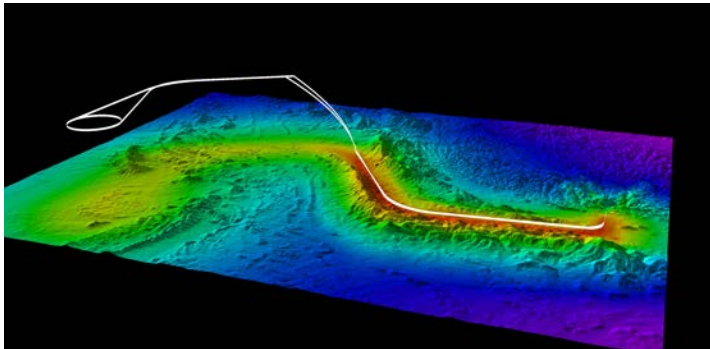
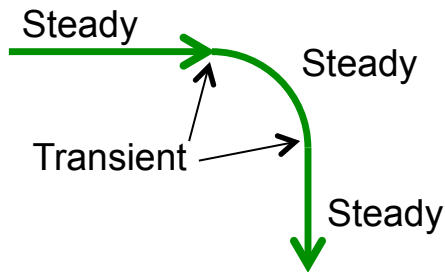
Maneuver Acoustic Flight Test of the Bell 430 Helicopter

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Eglin 2011 NASA/Bell/Army Maneuver Test



- Test executed from June 6 thru July 3, 2011
- Objectives
 - Understand maneuver acoustics
 - Validate ground footprint acoustic codes
 - Incorporate maneuvers into acoustic ground footprint prediction codes
- Acoustic measurement of
 - Source noise
 - Steady and transient maneuvers
 - Approach profiles
- Large test crew: 23 people from 7 organizations
- Acquired 410 individual data points over 10 testing days and 30.6 flight hours
- All “Priority One” and “Priority Two” test conditions measured

NASA/Bell/Army Team



Outstanding test team
composed of

- 3 NASA
- 2 Army
- 10 Bell
- 3 Lockheed
- 2 Air Force
- 1 UMD
- 2 Ole Miss

And many more
involved in planning
and support

Bell 430 Test Aircraft



4 Bladed main rotor, 2 bladed tail rotor

- 8500 lb gross weight
- 143 ktas max continuous speed @SL
- Stacked semi-rigid rotor
- Aircraft measurements
 - Accurate positioning in space (DGPS)
 - Aircraft attitudes, rates, and speed
 - Control positions
 - Tip Path Plane measurement



Mobile Acoustic Facility



Command & Control Trailer

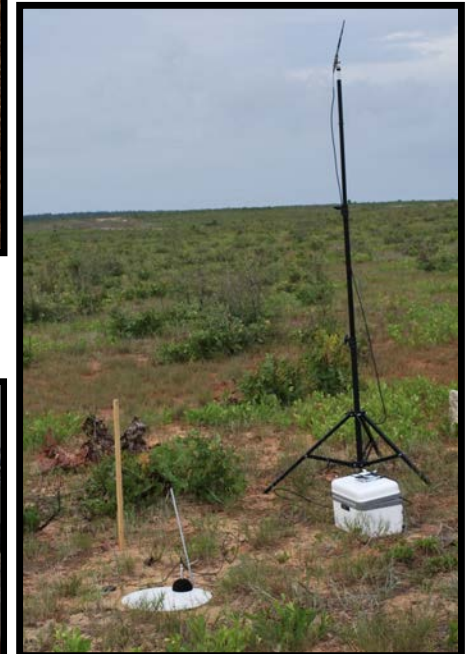


Wireless Acoustic Microphone Systems (WAMS)

Microphone on Ground
Board



WAMS



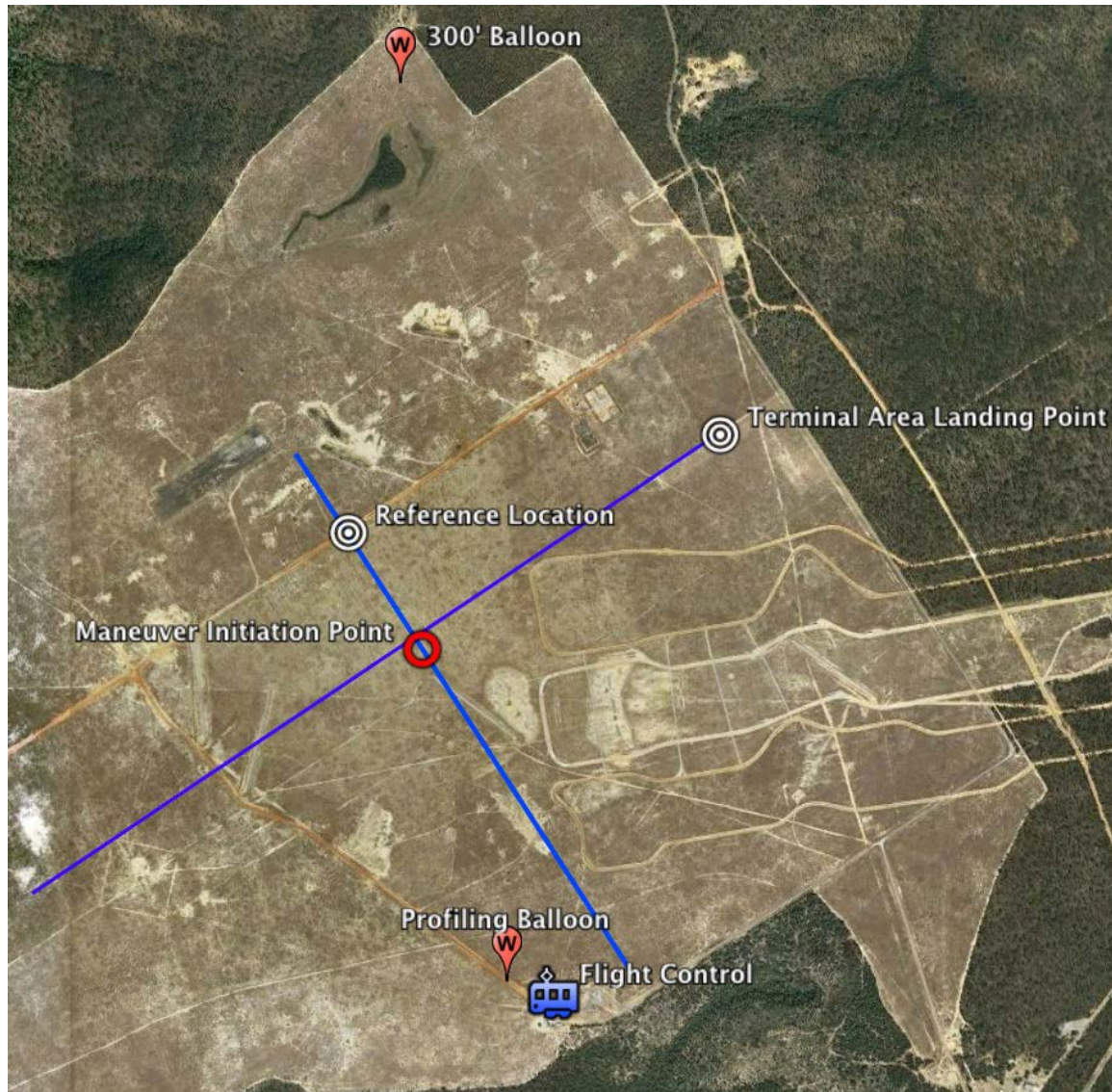
WAMS Trailer



Weather
Balloon



Test Range Overview



Source Noise Mapping

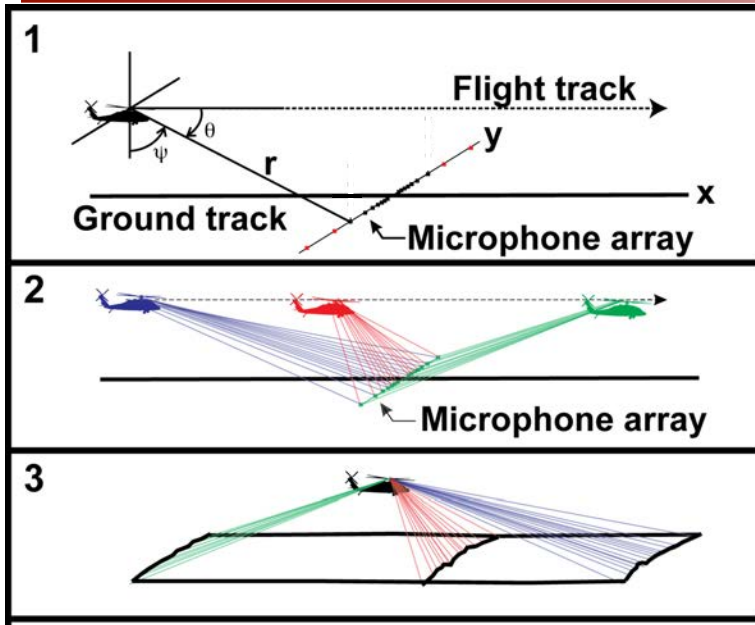


- Acquire detailed hemispheres for use in optimization codes and ground footprint calculations
- Linear array 21 microphone locations

Level Flight Points		
Airspeed (KIAS)	Gear Up	Gear Down
50	1	
60	5	
70	2	
80	11	2
90	1	
100	2	
110	1	2
120	3	
130	5	

Descent Points						
Airspeed (KIAS)	Descent Angle (Degrees)					
	3	6	7.5	9	10.5	12
50		3		1		
60	4	4	2	3	3	3
70		3	1	2		2
80	2	4	5	2	3	2
90		2	1	1		

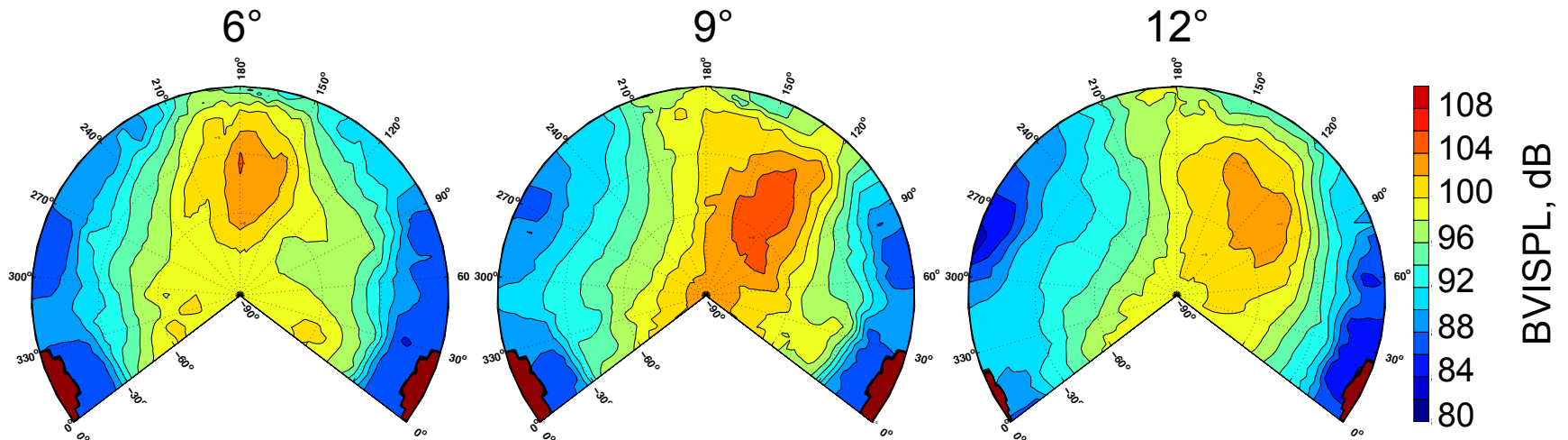
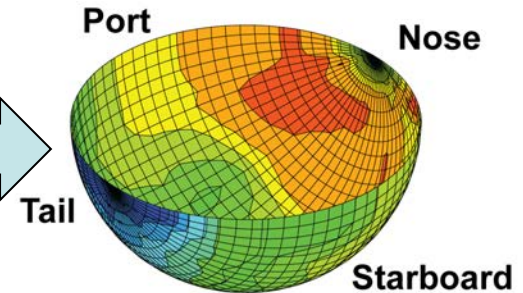
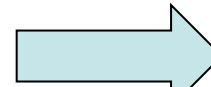
80 KIAS Steady Descent Semi-sphere



Acoustics measured continuously during flyover

Directivity angles and ranges calculated

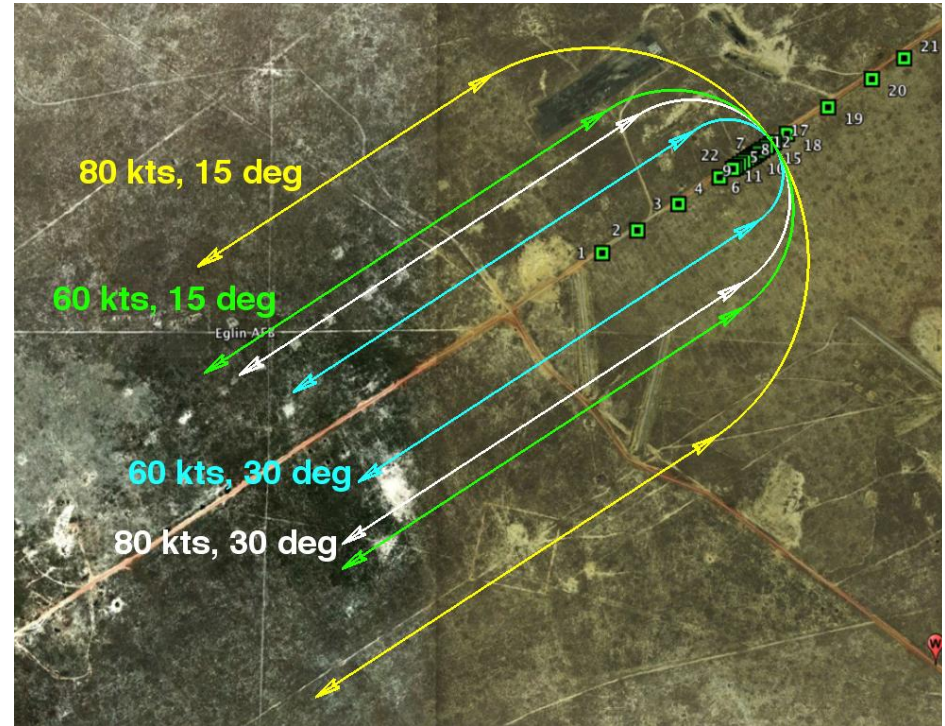
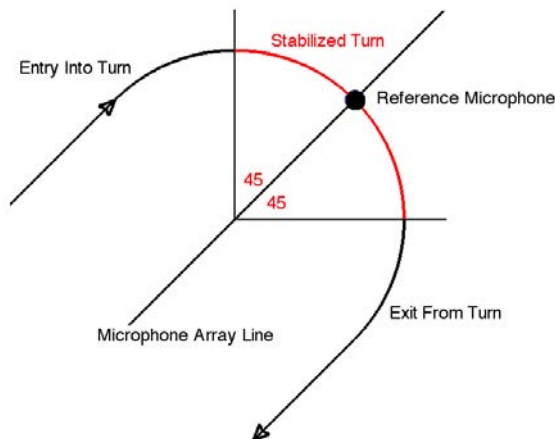
Range vectors translated to single point



Steady Turns



- Acquire data to:
 - Validate acoustic prediction codes
 - Incorporate steady coordinated turns into transition part of terminal area approach predictions
- Source linear array
- Left and right steady bank angles
- 15 and 30 degree banks



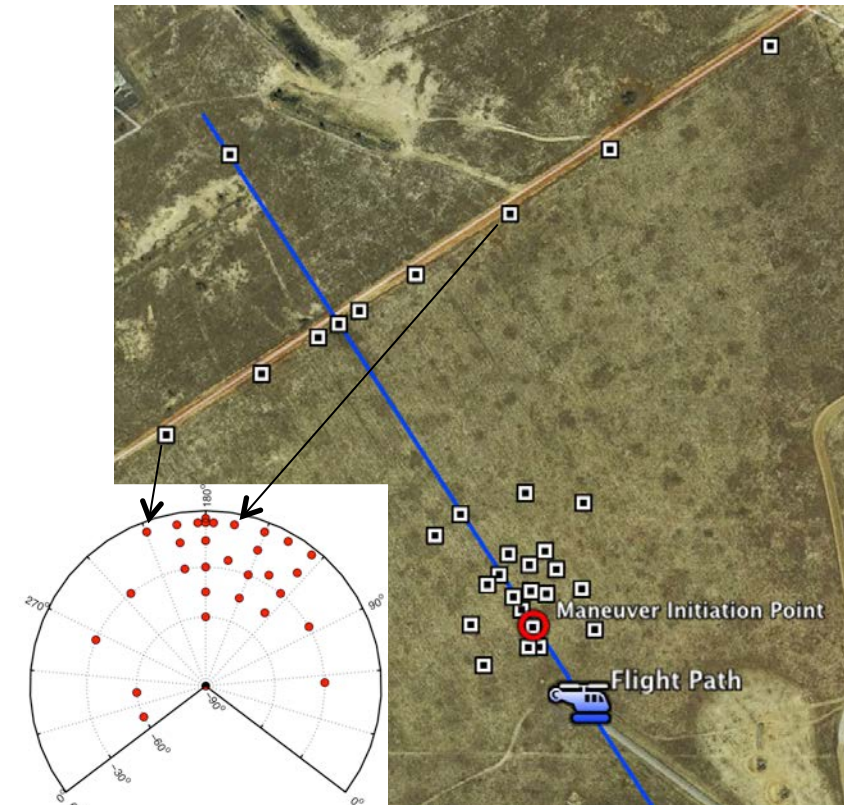
Steady Turn Points				
	Bank Angle (degrees)			
	15		30	
	R	L	R	L
Airspeed				
60	6	2	7	3
80	2	2	11	7

Transient Maneuvers

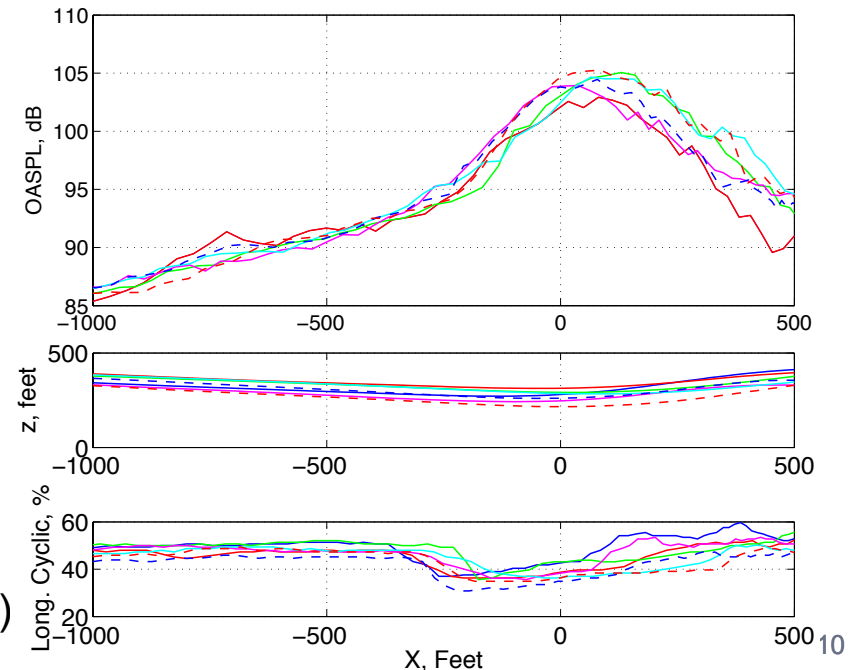


- Acquire data to:
 - Validate acoustic prediction codes
 - Understand the effect of dynamic changes in flight condition on acoustics
- 31 microphones
- Maneuvers initiated from 60/80 kts, level flight and $6^\circ/9^\circ$ descents
- Slow, medium and fast control inputs

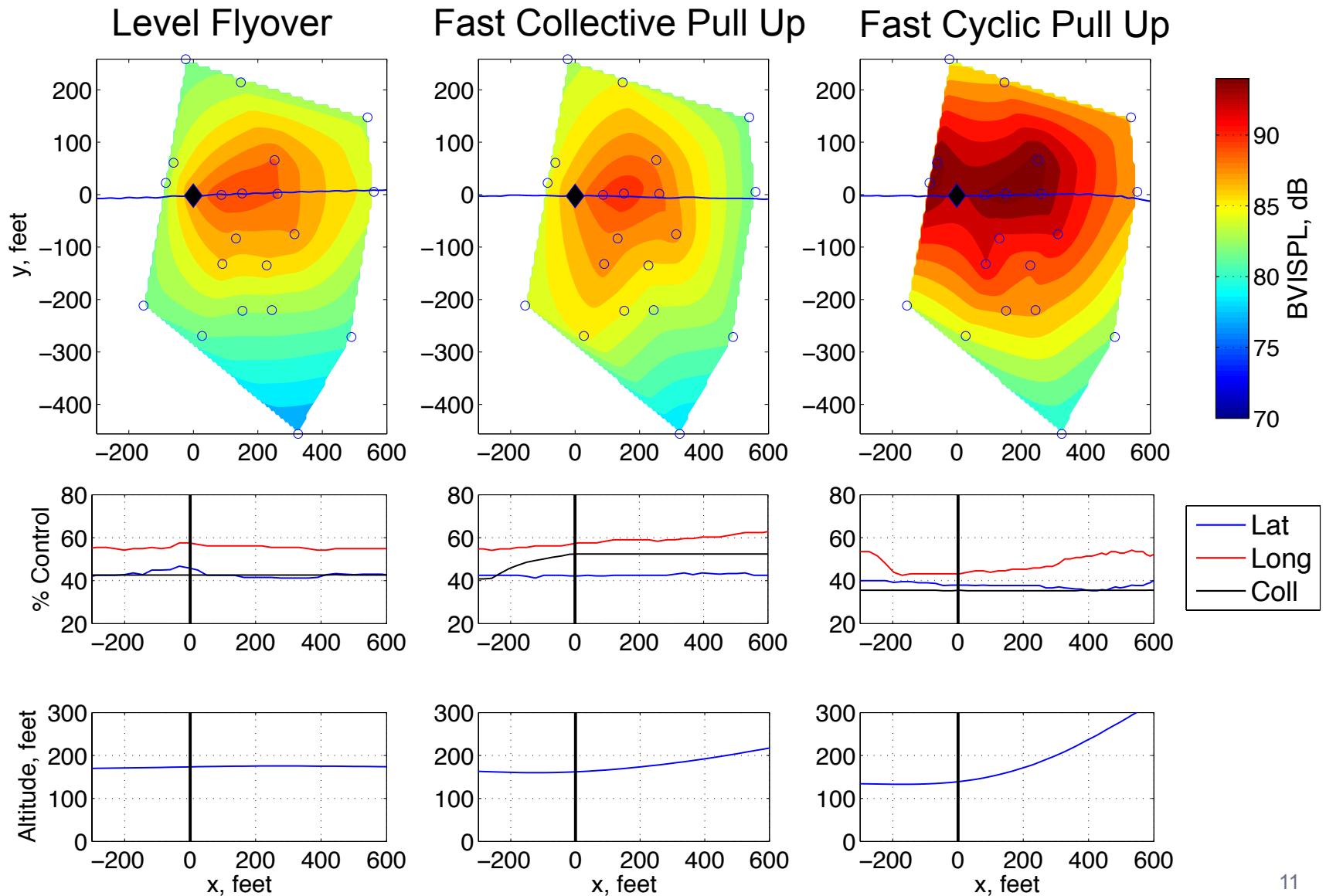
80 KIAS, 6° Fast Cyclic Pitch Up Housekeeping



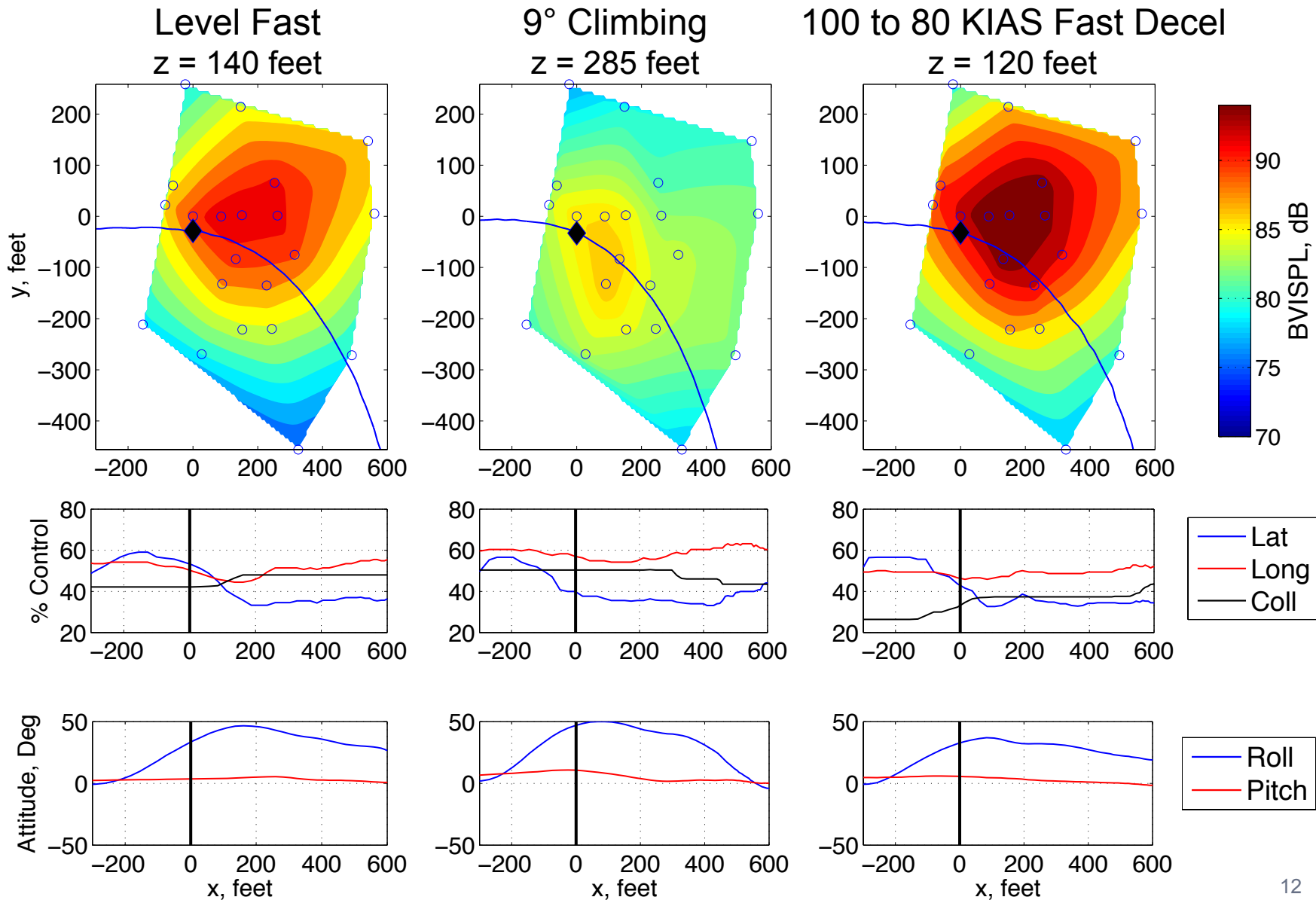
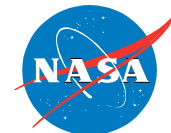
- Single control input
 - Collective pull-up, push over (25)
 - Cyclic pitch-up (55), roll (87)
- Combination maneuvers
 - Quick stop/start (16)
 - Accelerating roll angle change (22)
 - Climbing flight roll angle change (12)



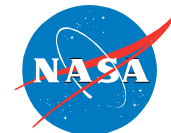
80 KIAS Maneuvers



80 KIAS Right Rolling Maneuver

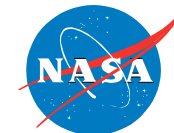


Terminal Area Approaches

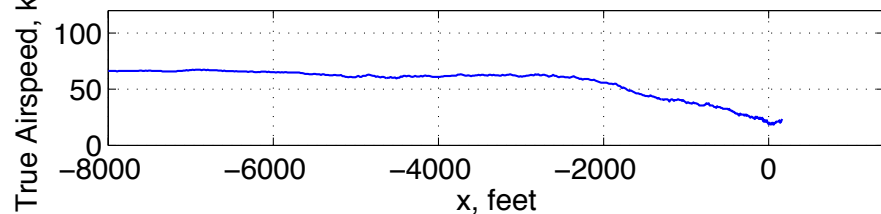
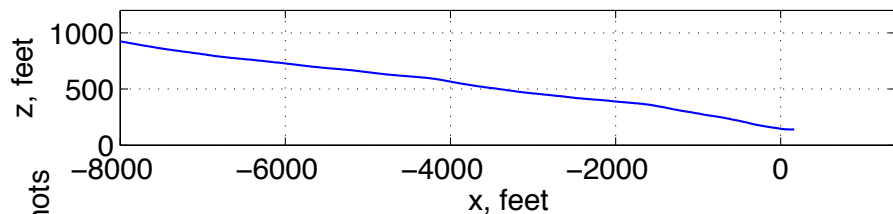
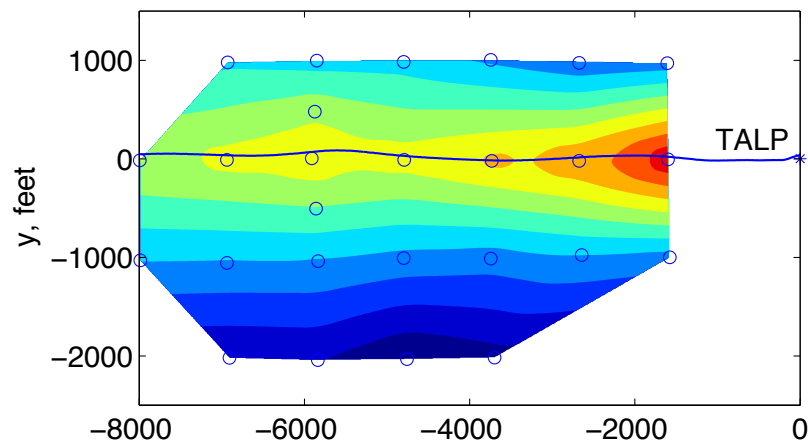


- Purpose is to gather data for validation of ground footprint prediction and flight path optimization codes
- 27 Microphones deployed in grid
- Approaches
 - Constant glide slope
 - Multi-segmented linear
 - Three dimensional
 - Pilot's discretion
- 26 Approaches Acquired

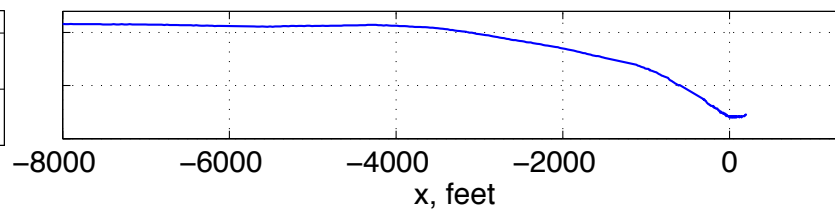
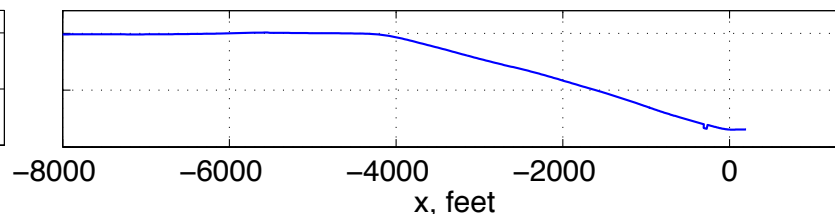
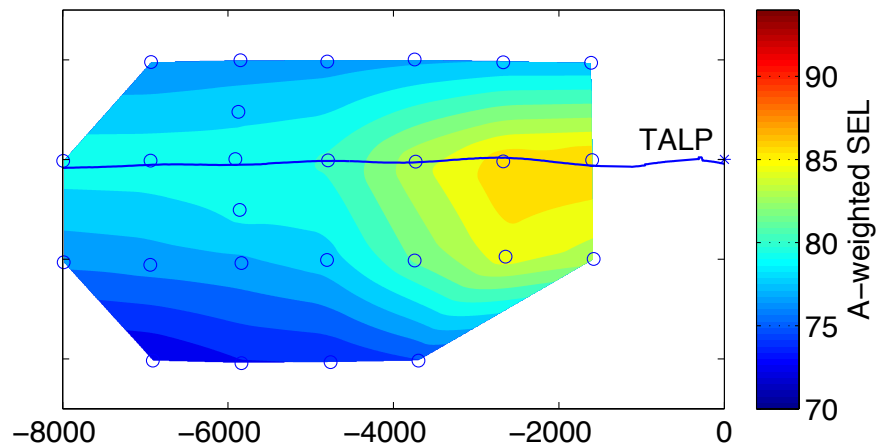
Terminal Area Approach Data



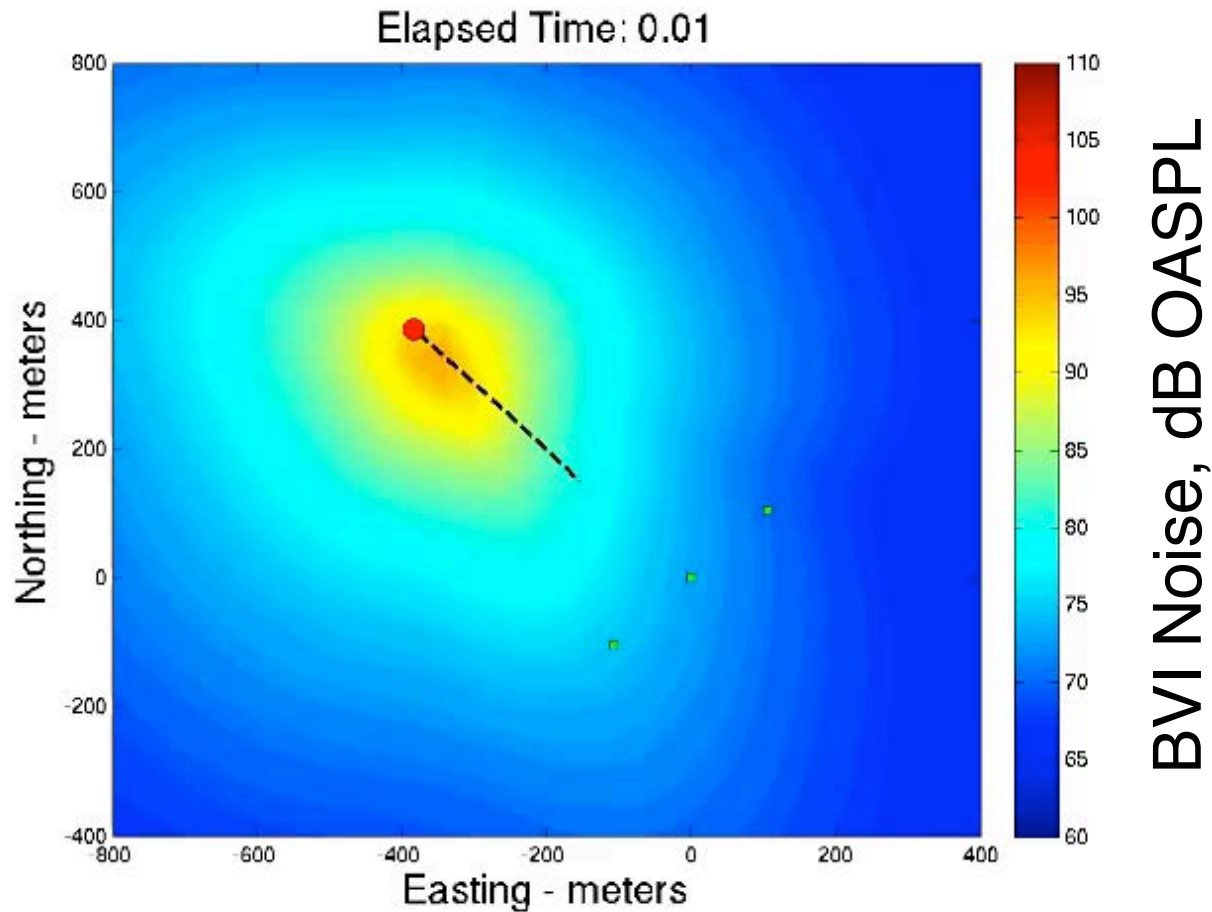
6° Standard Approach



12° Fast Decelerating Approach



FRAME Transient Maneuver Modeling



- Bell 206B, two-bladed teetering main rotor
- Fast pitch up from 60kts level flight.
- University of Maryland / Bell Helicopter / NASA / Army Program at Gilroy, CA 2007

Summary



- A successful, cooperative acoustic flight test involving seven organizations was performed on a Bell 430 helicopter at Eglin AFB.
- The test acquired 410 good quality data points for level, descending, climbing and maneuvering flight.
- This test thoroughly investigated the acoustics of maneuvering helicopters.
- The unique, high quality data set will be used to design and validate acoustic predictive codes with applications ranging from basic source noise prediction to the design of low noise terminal area operations.

Questions?



