

# Automobile Engine Nearfield Acoustic Holography with Array 24

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# Background

- Beamforming = Processing method for incoherent sources
  - Often ideal for aeroacoustics
  - Resolution is poor at low frequency
  - Can be confused by coherent source distributions if the array is in the nearfield
    - Supersonic jet noise
    - Mechanical vibrations
    - Fan tones
- OptiNav GINV
  - Developed in a Navy SBIR project
  - Generalized Inverse implementation of Nearfield Acoustic Holography
  - Works best when the array is in the nearfield and at least as wide as the source
  - Most efficient at low frequency (below 6 kHz for Array 24)
  - Not restricted in array design; works with Array 24 and Array 48 existing products
  - Not confused by coherent or incoherent source distributions
  - Can produce quantitative far field projections (not shown here)



# Array 24 in Nearfield Configuration

Spotlight used to provide light for array camera



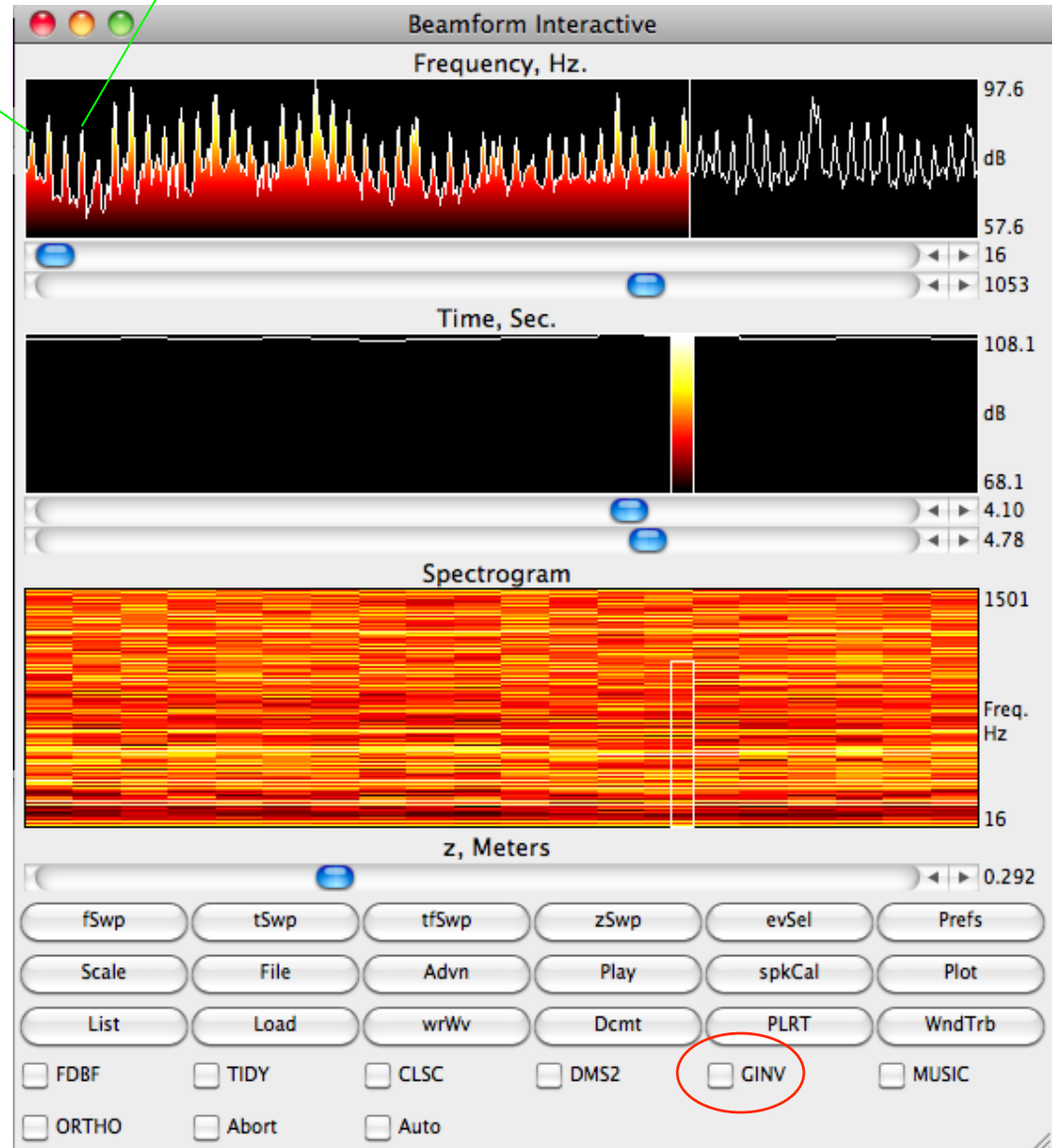
# Beamform Interactive Dialog

3000 RPM, 4 cylinder, 4-stroke engine

Engine Firing Rate = 105 Hz  
Engine Order = 2

Lowest tone frequency:  
Cylinder Firing Rate =  $3138/120$   
= 26 Hz  
Engine Order = 1/2

Data acquisition time = 6 seconds  
Time used for analysis = 0.68 sec.



# Results (1/6)

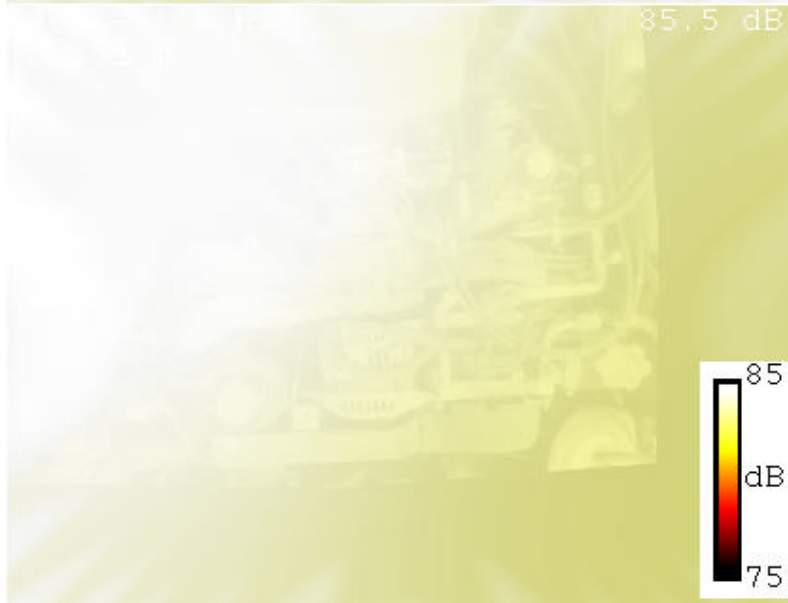
## Beamforming

## NAH (GINV)

26 Hz  
EO = 0.5  
CFR



52 Hz  
EO = 1.0

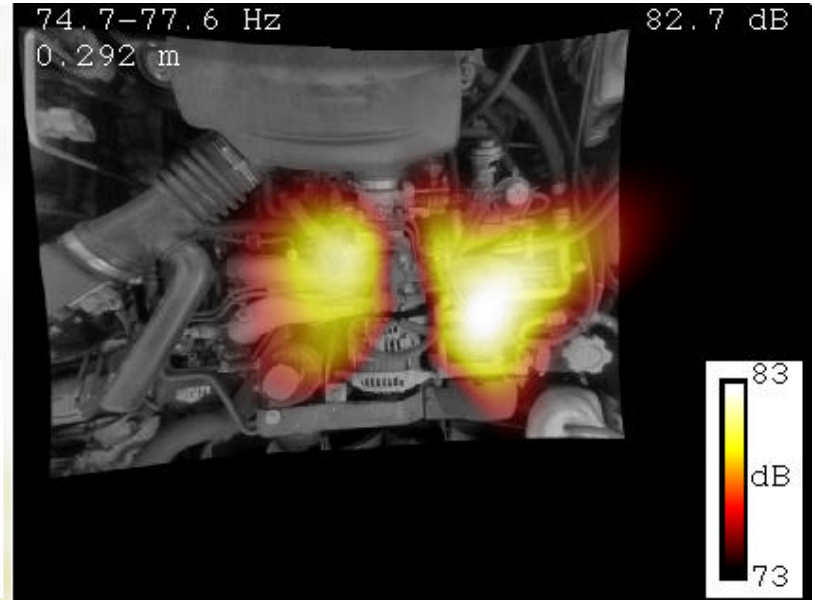


# Results (2/6)

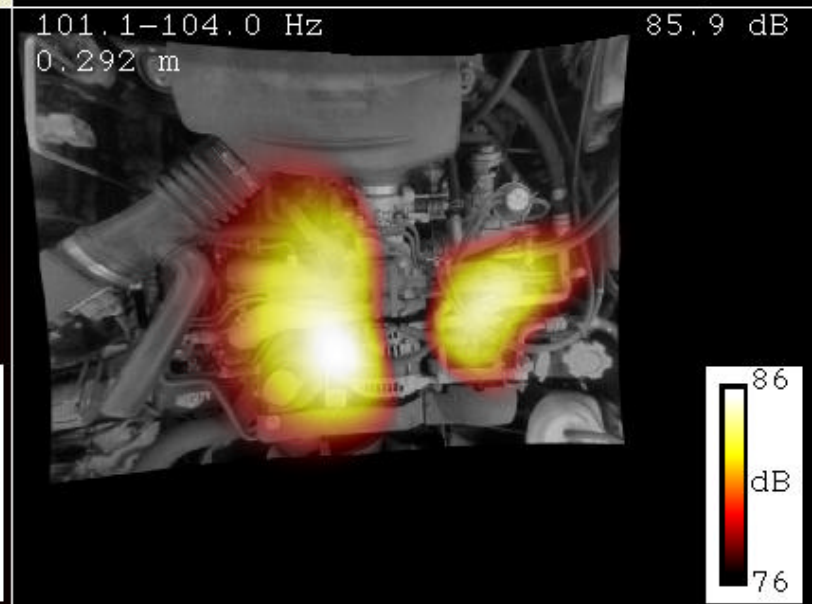
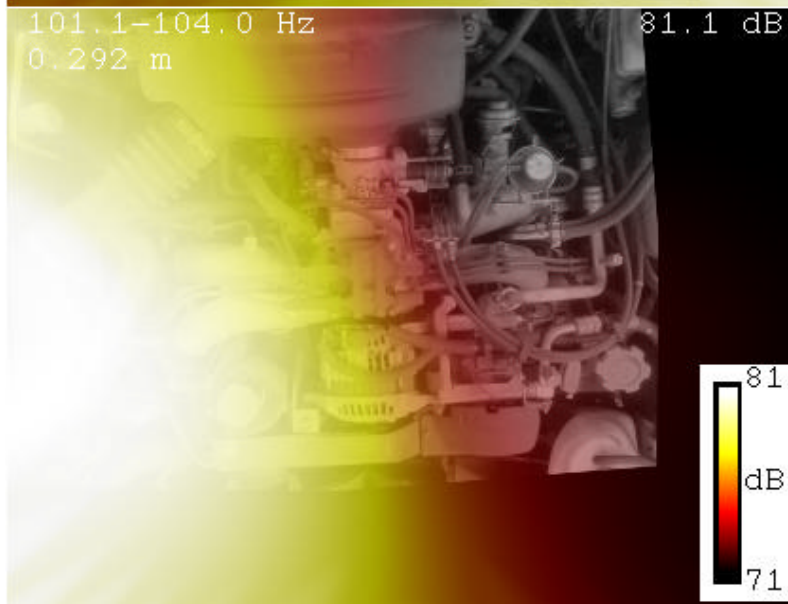
## Beamforming

## NAH (GINV)

78 Hz  
EO = 1.5



105 Hz  
EO = 2.0  
EFR

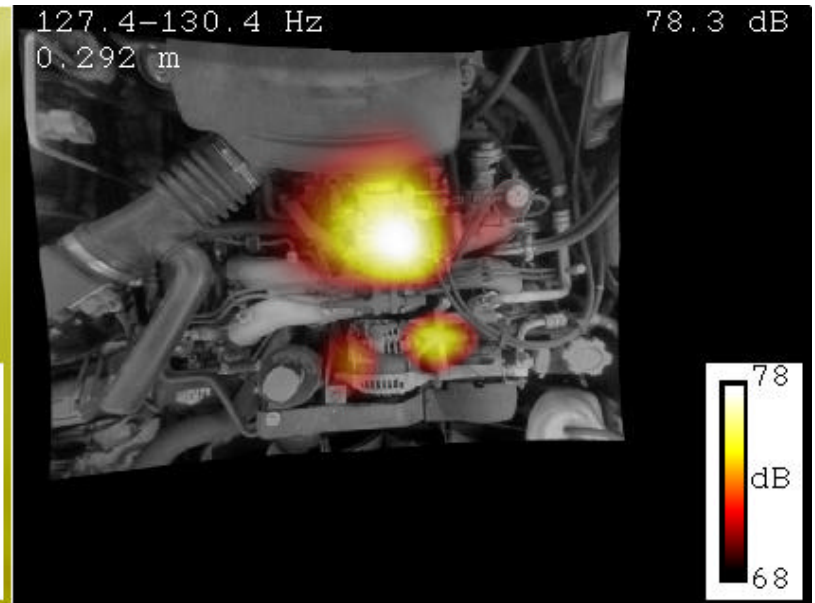


# Results (3/6)

Beamforming

NAH (GINV)

130 Hz  
EO = 2.5



157 Hz  
EO = 3.0

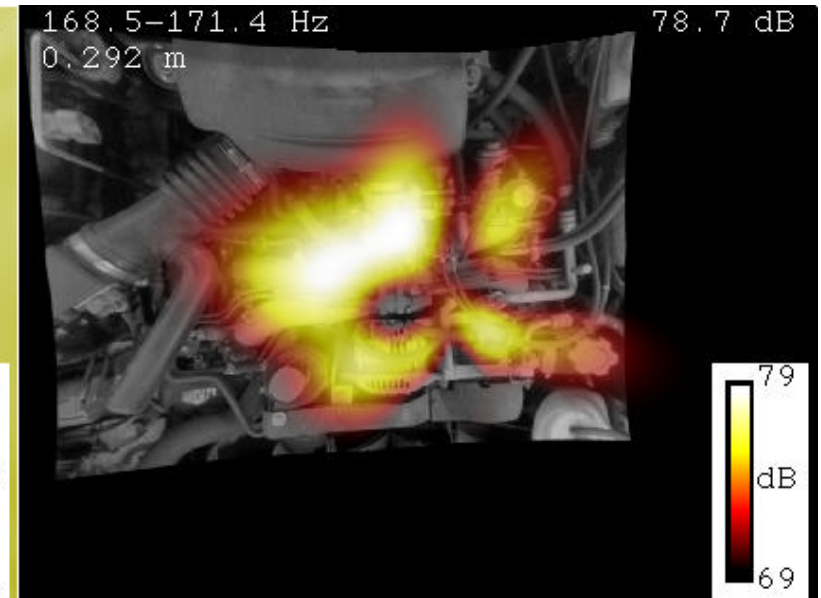


# Results (4/6)

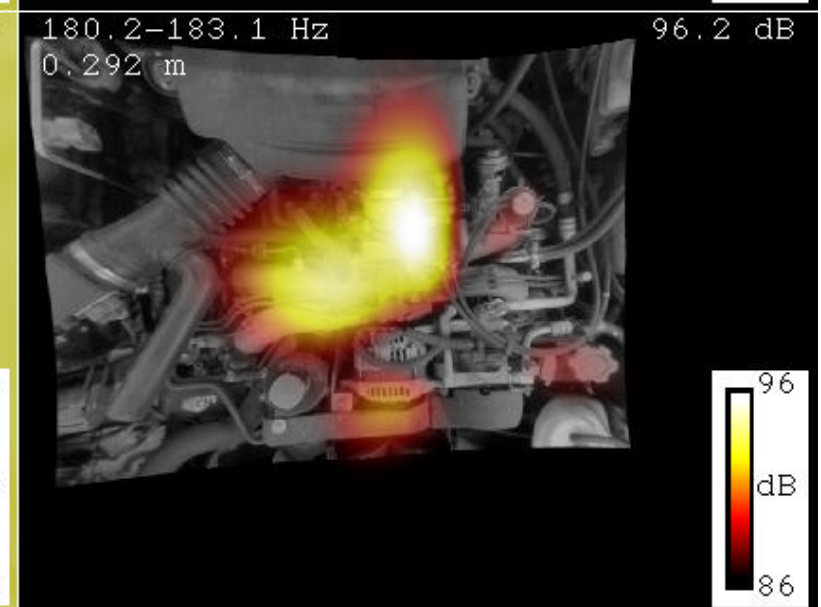
Beamforming

NAH (GINV)

171 Hz  
EO = 3.27  
(not  
cylinders)



183 Hz  
EO = 3.5

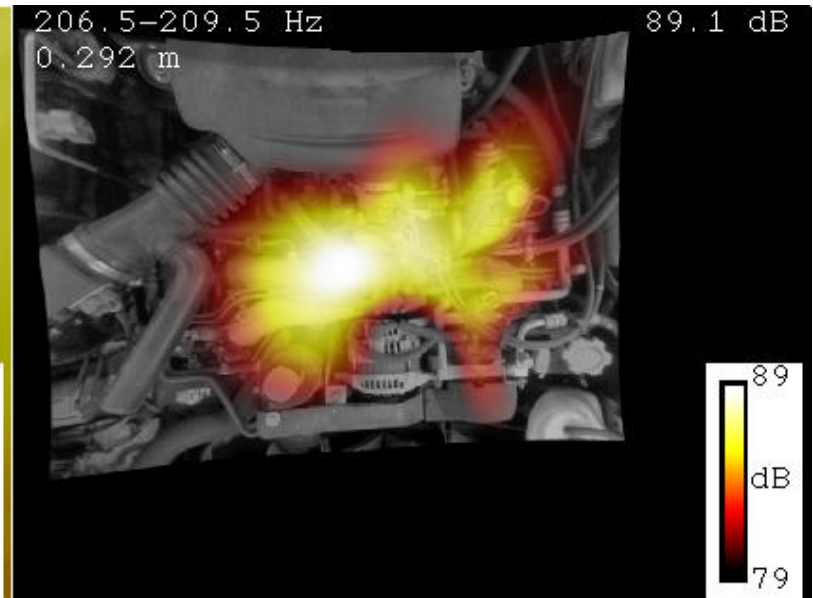
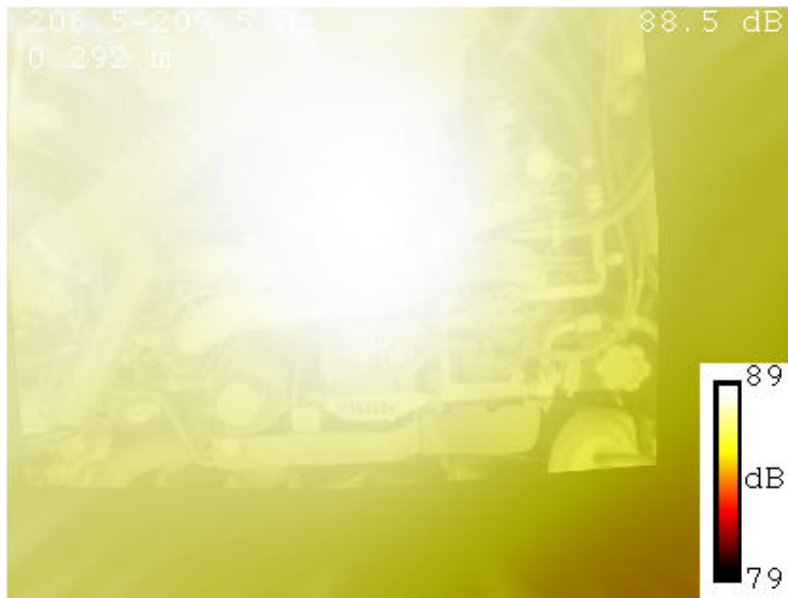


# Results (5/6)

## Beamforming

## NAH (GINV)

209 Hz  
EO = 4.0



224 Hz  
EO = 4.28  
(not  
cylinders)



# Results (6/6)

## Beamforming

## NAH (GINV)

235 Hz  
EO = 4.5



261 Hz  
EO = 5.0

