Engine Stand Data for Flight Deck and Community Noise Predictions

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Military Noise Challenges

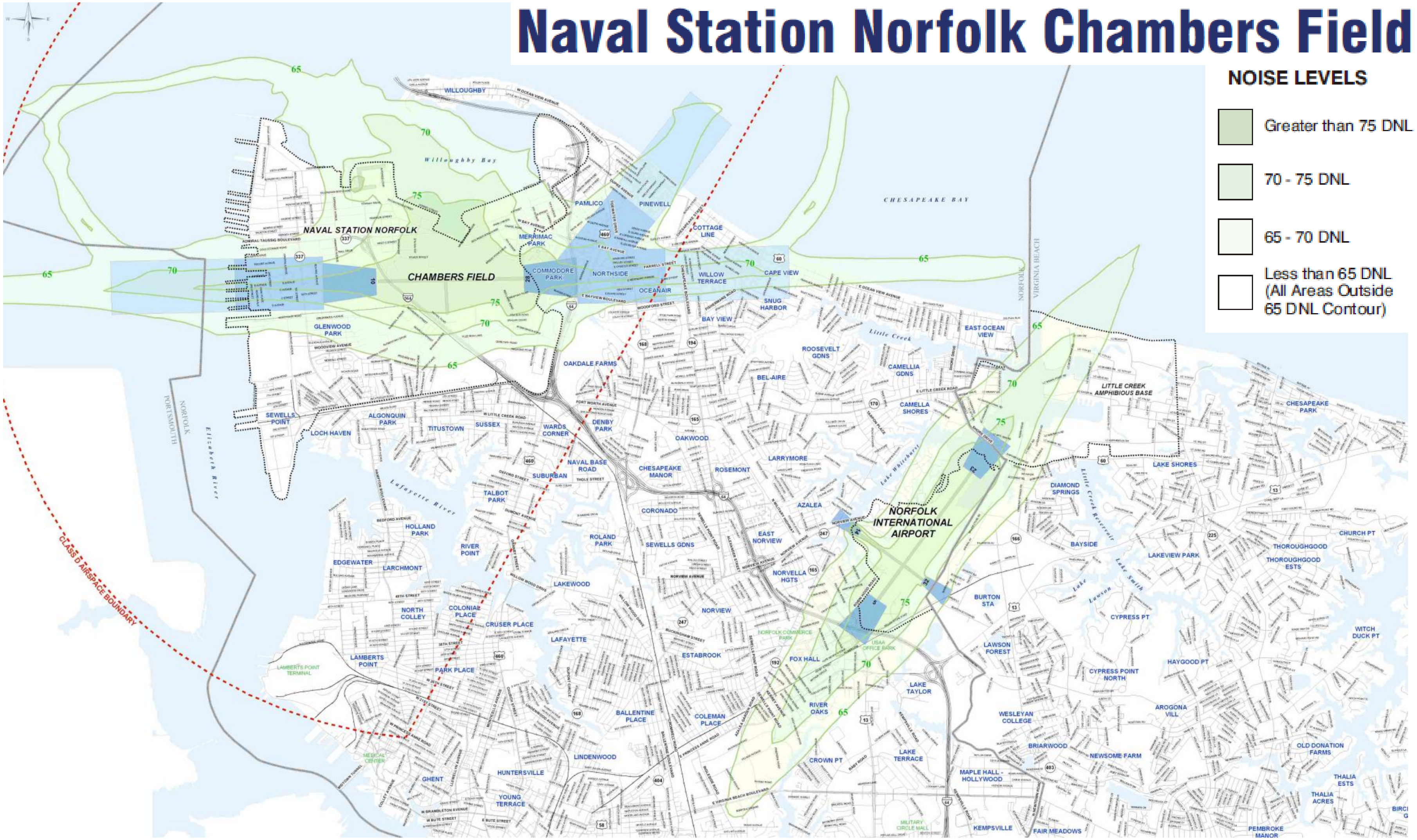
- **Community Noise**
  - Impact of airbases on surrounding community
  - Can impact/limit operations at airbases
  - Can have a financial impact
- **Flight Deck (Near-Field) Noise**
  - Impact of high intensity noise on flight deck personnel
  - Health issue
  - Has a financial impact
- **Accurate Prediction and Quantification of Noise**

Standard Challenges

- **Are we making the measurements we need to address the military noise challenges?**

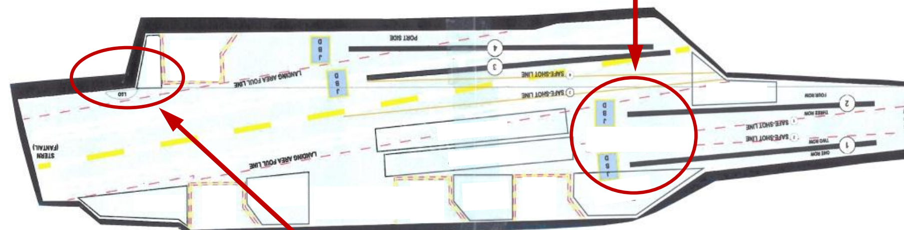
- **Where is the line between standard measurements and research?**

Community Noise



Joint Land Use Study (JLUS)/Air Installations Compatible Use Zones (AICUZ) Planning Map 2010

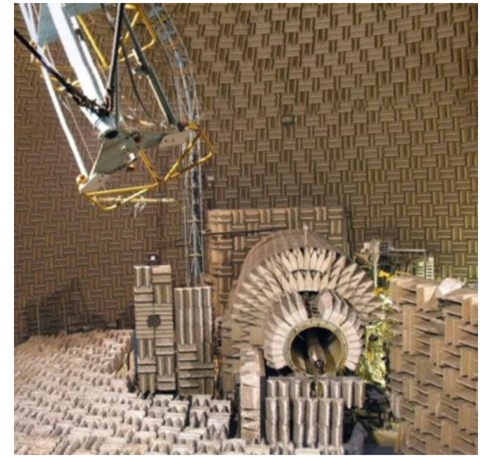
Flight Deck Noise Environment



Carrier Deck Qualifications

Options for Addressing Military Noise Challenges

- **Laboratory Scale Measurements**
  - Anechoic environment
  - Controlled experiments
    - Isolate effects
    - Employ range of diagnostic techniques
  - Limited exhaust temperatures, forward flight, scale
  - Flow may be “ideal” relative to full-scale engine exhaust
- **Engine Stand Measurements**
  - Realistic exhaust conditions with all turbomachinery effects
  - No scaling issues
  - No forward-flight or installation effects
  - Not anechoic and environmental effects always present
  - Limitation on diagnostics
- **Flight Measurements**
  - Capture all effects
    - difficult to isolate individual effects
  - Limited diagnostic tools
  - Error band larger



F-15 ACTIVE Flight Test (1997)

Cost, Realism, Development Stage

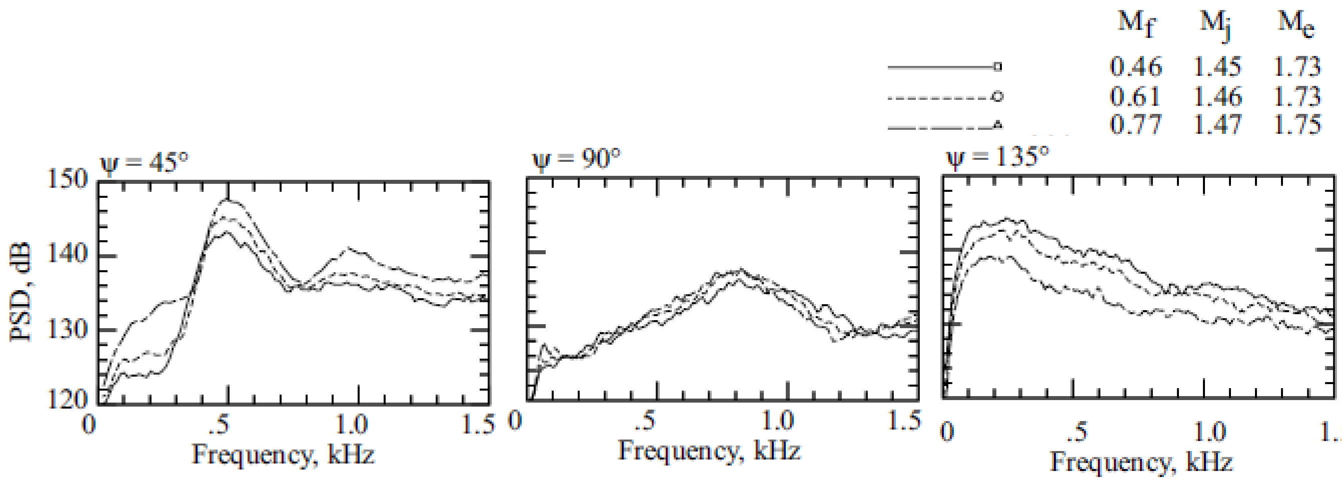
Use of Engine Stand Data for Military Noise Challenges

- **Community noise predictions**
  - Quantify source then use information in flight path/propagation program such as ANOPP (Aircraft Noise Prediction Program)
  - Challenges
    - Source does not include impact of forward flight or installation effects
    - Measurements may be impacted by ground effects
    - May need to quantify of non-linear propagation effects
    - Need to understand azimuthal directivity for non-circular configurations
- **Flight deck predictions**
  - Quantify exposure of personnel on the flight deck
  - Challenges
    - Measurements may not include solid surface effects (jet blast deflector, flight deck)
    - Missing installation effects
    - Advanced nozzle configurations will likely have azimuthally varying sound fields
    - Near-field propagation techniques have not been developed for TACAIR exhausts so propagating measured near-field data to other near-field locations will be difficult

Use of Engine Stand Data for Military Noise Challenges

- **Accurate Prediction and Quantification of Noise**
  - Includes noise from “baseline” nozzle configurations and noise reduction devices
  - Challenges
    - Forward flight and installation effects can impact noise reduction

Use of Engine Stand Data for Military Noise Challenges
- Community Noise -
Forward Flight Corrections

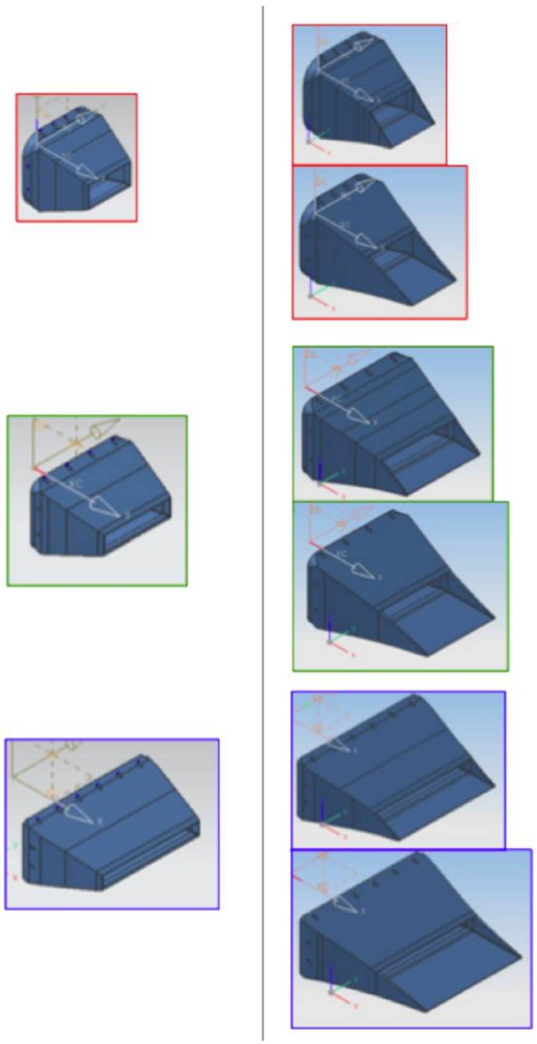


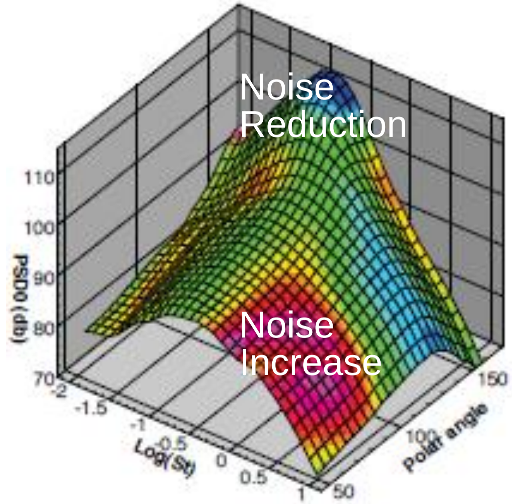
Norum, Garber, Golub, Santa Maria (2004), NASA/TP-2004-212686

- Significant flight corrections dataset from F-15 Active Aircraft test
- Flight corrections may be very different for non-axisymmetric jets
- Need additional research to understand flight corrections for non-axisymmetric jets

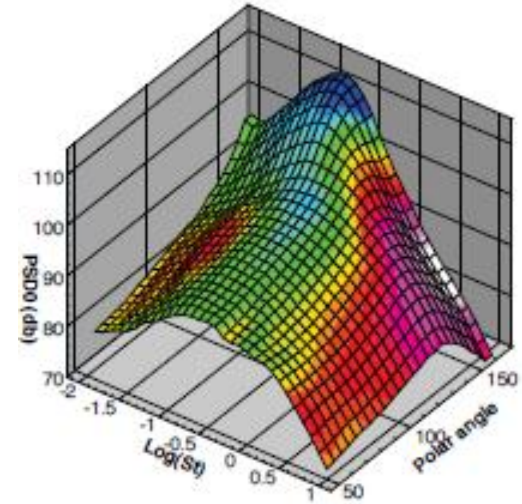
Use of Engine Stand Data for Military Noise Challenges
- Community and Flight Deck Noise -

Azimuthal Variation





azimuthal angle= 90°



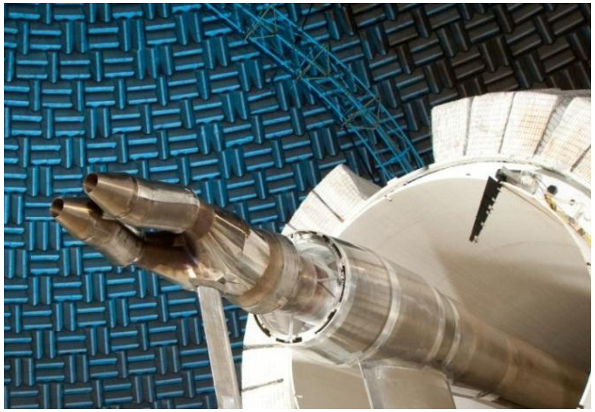
azimuthal angle= 180°

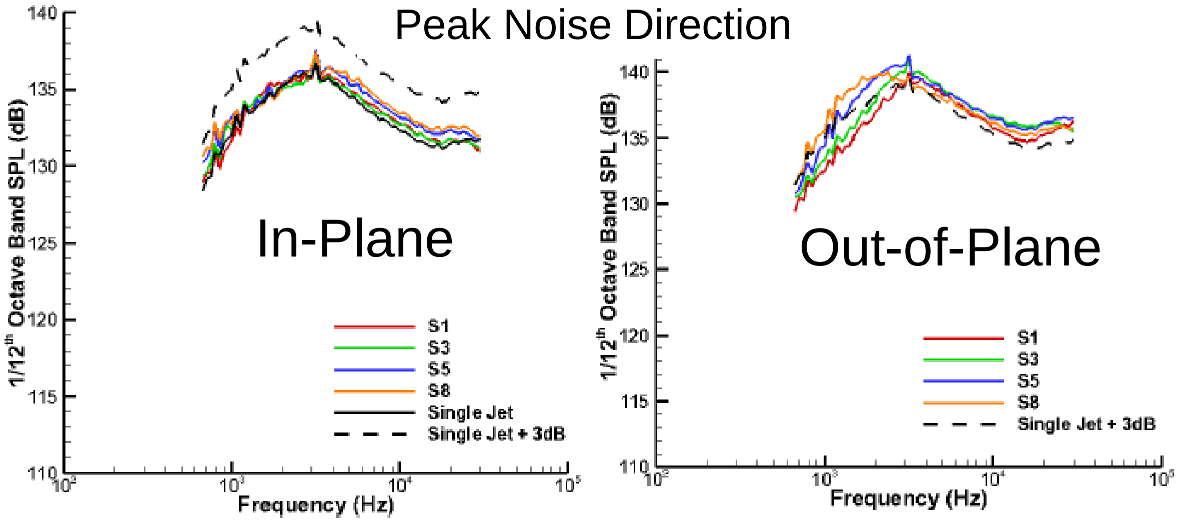
Bridges (2012), AIAA-2012-2252

- Advanced nozzle configurations have azimuthal and polar sound-field variations

- Scale-model data exists for quantifying variations in subsonic jets

Use of Engine Stand Data for Military Noise Challenges
- Community and Flight Deck Noise -
Installation Effects





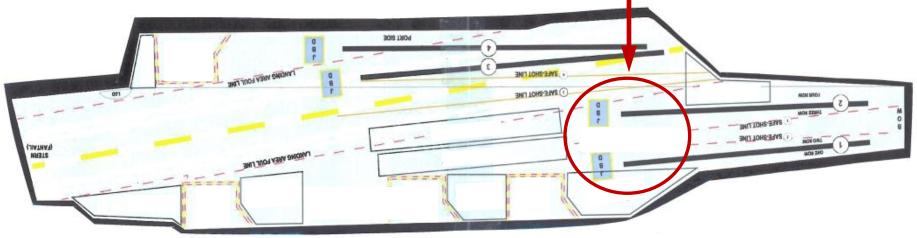
Bozak, Henderson (2011), AIAA-2011-2790

- Model scale data exists for round and rectangular twin jets
- How will multi-jet effects change for advanced configurations

Use of Engine Stand Data for Military Noise Challenges

- Flight Deck Noise, Accurate Quantification of Noise -

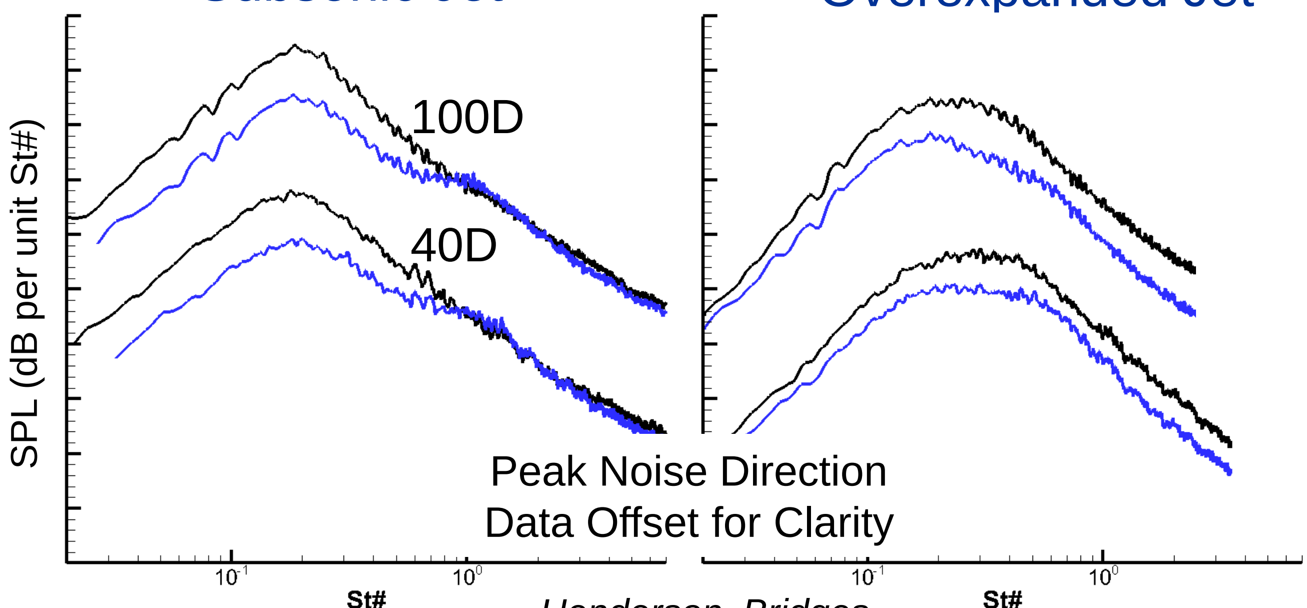
Measurement Location



Nimitz Flight Deck Width = 252’ ~ 126D
Assumes D = 2’

- Subsonic noise reduction similar at 100D and 40D
- Supersonic noise reduction is different in mid and far field

Subsonic Jet — Overexpanded Jet



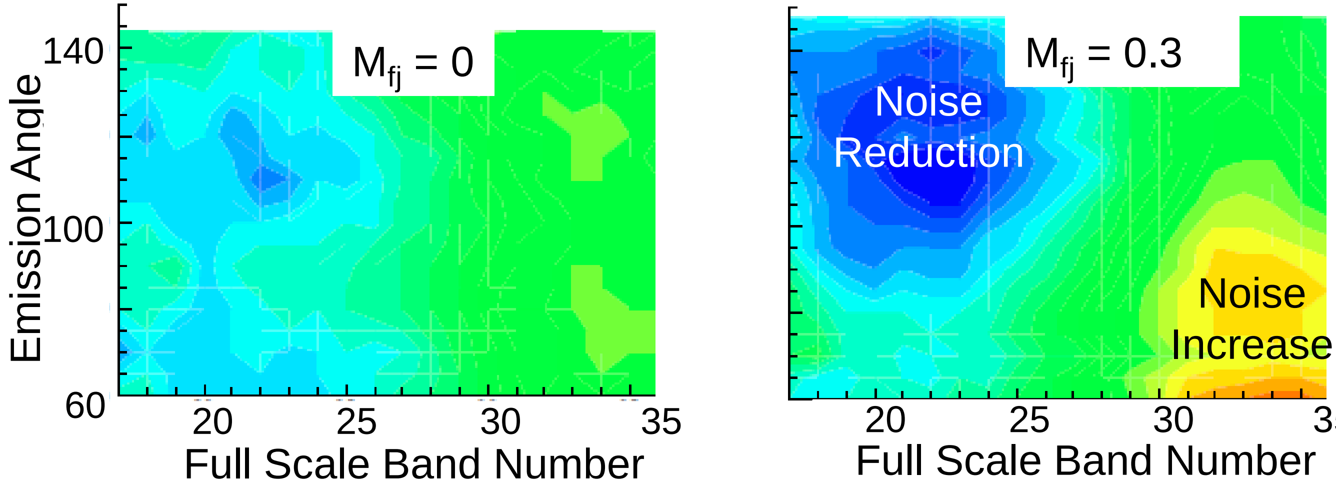
Peak Noise Direction
Data Offset for Clarity

Henderson, Bridges

Use of Engine Stand Data for Military Noise Challenges
- Accurate Prediction and Quantification of Noise -

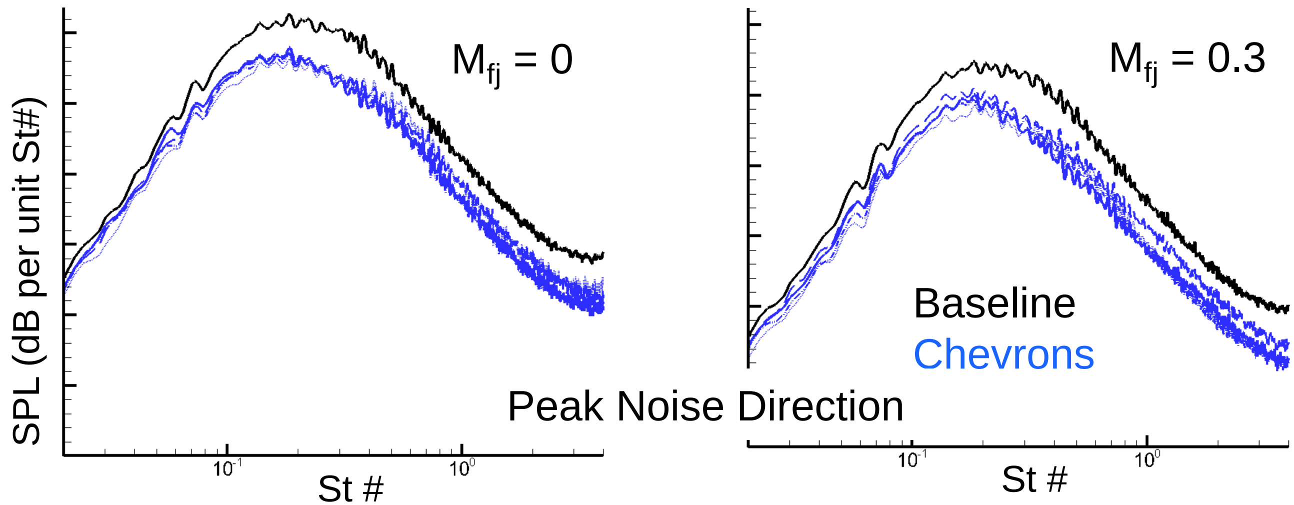
Noise Reduction and Forward Flight

Subsonic Jet Chevron Noise Reduction



Nesbitt, Young (2008), AIAA-2008-3065

Overexpanded Jet Chevron Noise Radiation



Henderson, Bridges (2010), AIAA-2010-3926

Questions/Comments

- **What types of measurements will be needed in the future**
  - Will we need measurements in the extreme far-field or will additional fundamental research provide us with adequate propagation tools
  - What will be the azimuthal requirements for future engine architectures/nozzles and has this been considered in the development of the standard
  - Will we need to include additional realism such as JBDs as a requirement for flight-deck noise quantification
  - Can we learn enough about flight and relevant installation corrections that follow-on flight tests will not be needed
- Have we clearly defined the intent of the proposed standard
  - Where is the line between research type measurements and measurements that fall within the scope of the standard