# Direct Acoustic Verses Reverberant Acoustic Testing Of The Cloud Profiling Radar Instrument

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# Summary

- Cloud Profiling Radar (CPR) Acoustic Test Configuration
- CloudSat Acoustic Test Configuration
- Instrumentation locations
- CPR and CloudSat Acoustic Test Input Comparisons
- Photos of CPR and CloudSat spacecraft in test set ups
- Reverberant & Speaker Test Responses Compared
- Diffuse, Normal & Grazing Wave Test Efficiency
- Conclusions

# CPR Acoustic Test Configuration

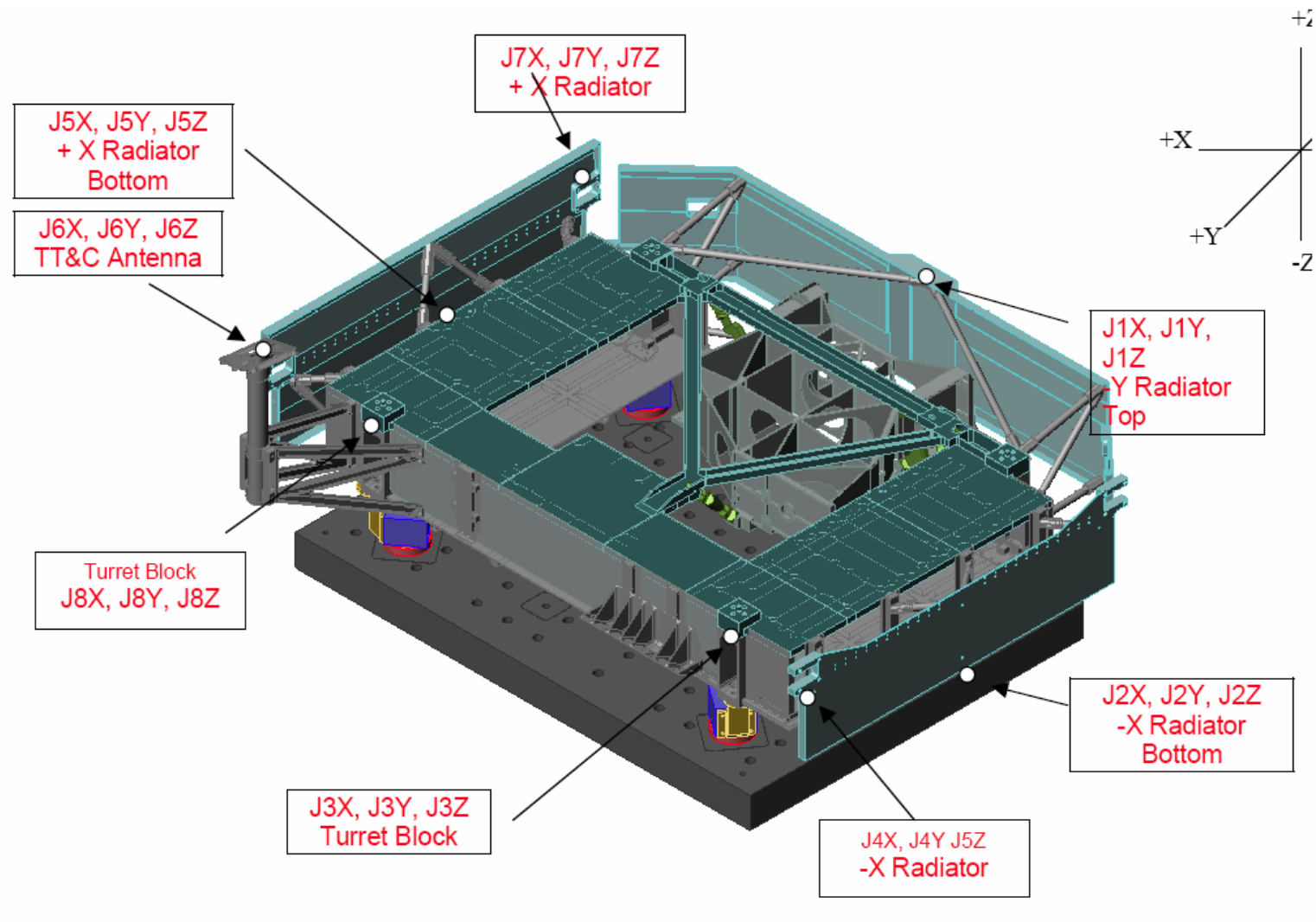
- Cloud Profiling Radar (CPR) on CloudSat spacecraft
  - Advanced radar used to image cloud formation structures on Earth
  - First satellite to image clouds globally

- CPR instrument structure acoustic tested with mass mockups . . .
  - Tested to initial program acoustic specification of 143.0 dB OA
  - PF acoustic test performed in reverberant chamber with instrument installed on transportation fixture at CPR hard points
  - Included structure, all reflectors, radiators and TT&C antenna mockup
  - Mass mockups in place of electronics
  - PF acoustics was performed to 143.0 dB overall at TRW in Manhattan Beach
  - Acoustic levels were computer controlled with feedback from 4 microphones
  - A single 60 second PF test run performed

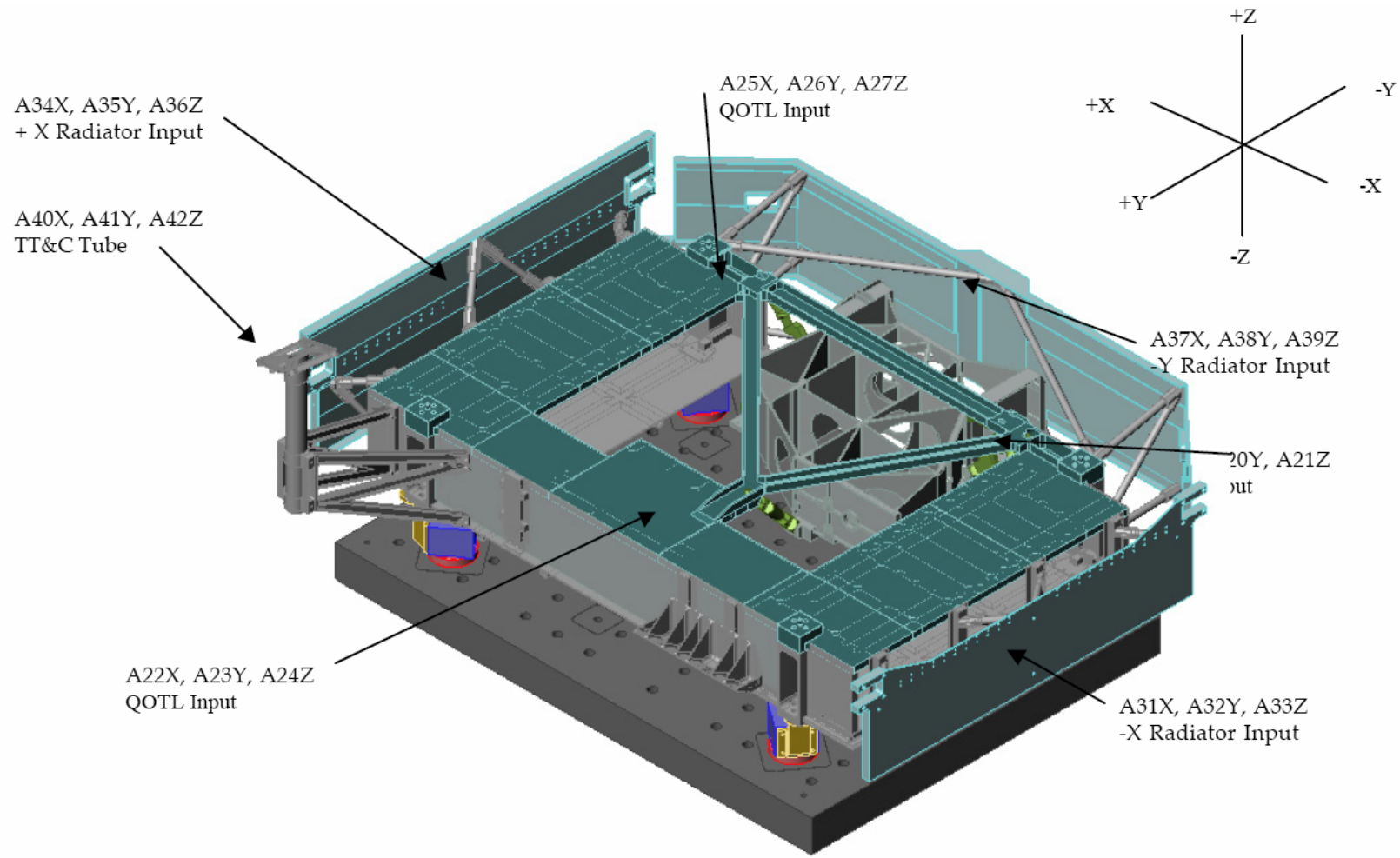
# CloudSat Acoustic Test Configuration

- CPR instrument installed on CloudSat spacecraft for system acoustic tests
  - Tested to reduced acoustic specification due to reduced acoustic environment of DPAF interior, 138.0 dB OA
  - CPR inflight configuration , all electronics installed, CPR structure unchanged
  - CloudSat acoustic testing performed at Ball Aerospace, Boulder, CO
  - Maryland Sound International (MSI) was the vendor for the acoustic sound equipment and test services
  - Speakers and support equipment provided by MSI
  - Acoustic levels were controlled by an m+p controller with feedback from 4 microphones
  - Operators continuously monitored acoustic levels throughout the duration of the testing
  - Three 20 second test runs performed at full level to keep speakers temperature within safe limits

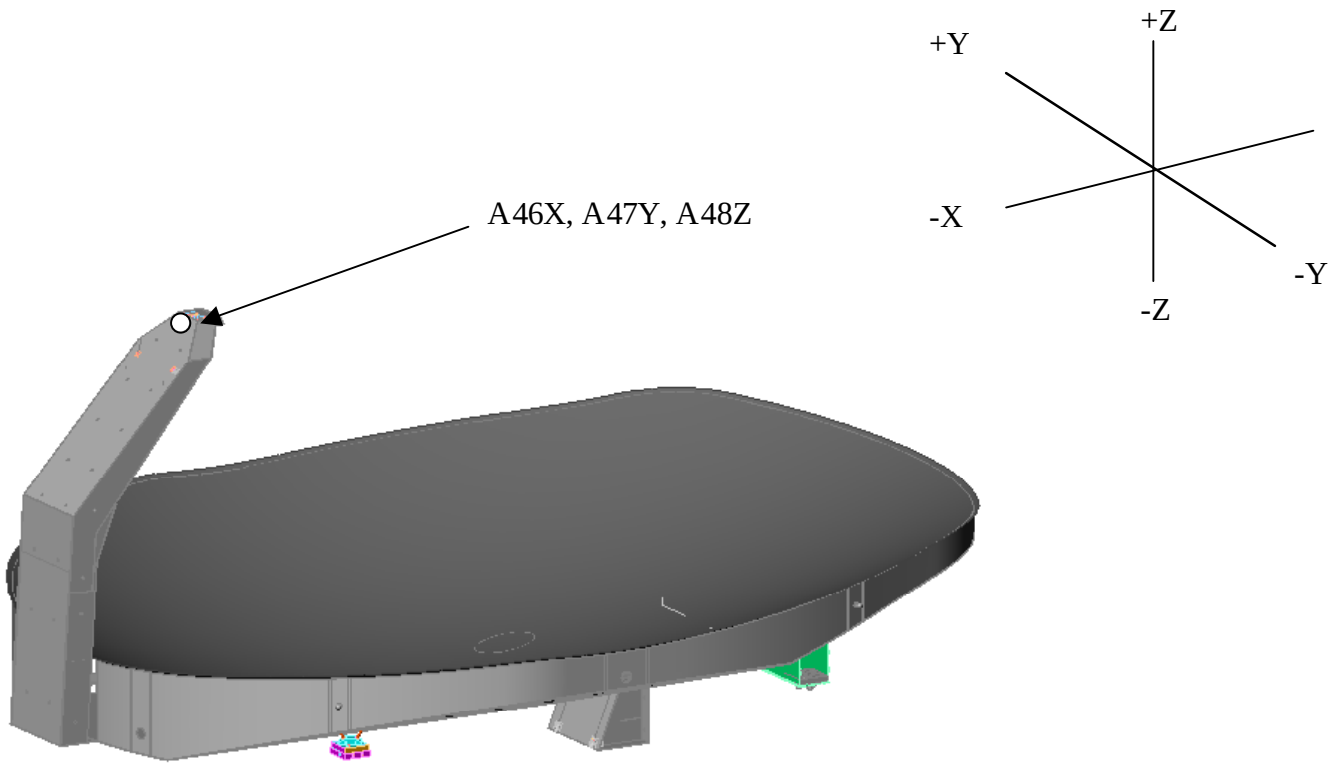
# CPR Common Accelerometer Locations



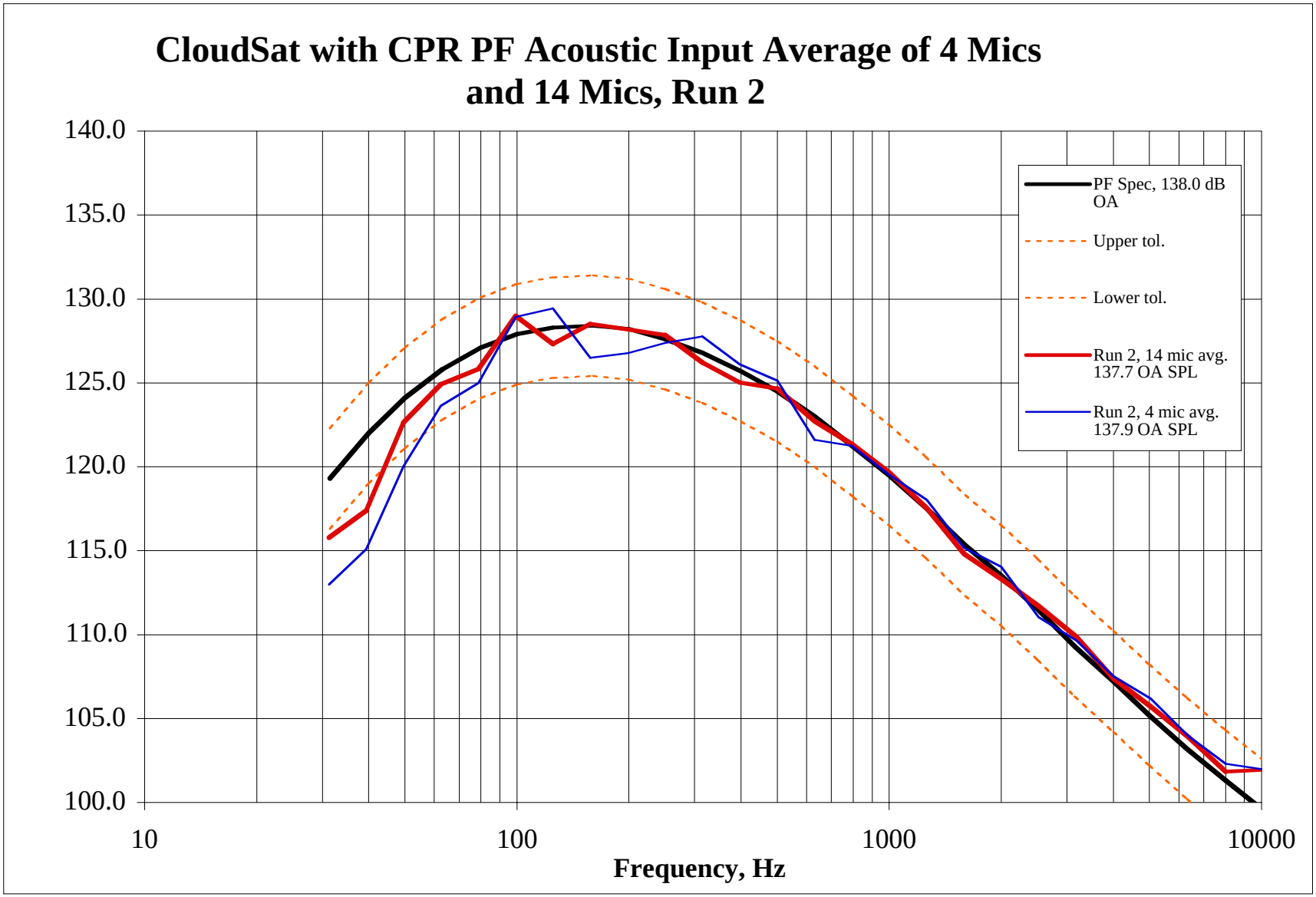
# Radiator Accelerometers for Reverberant Test



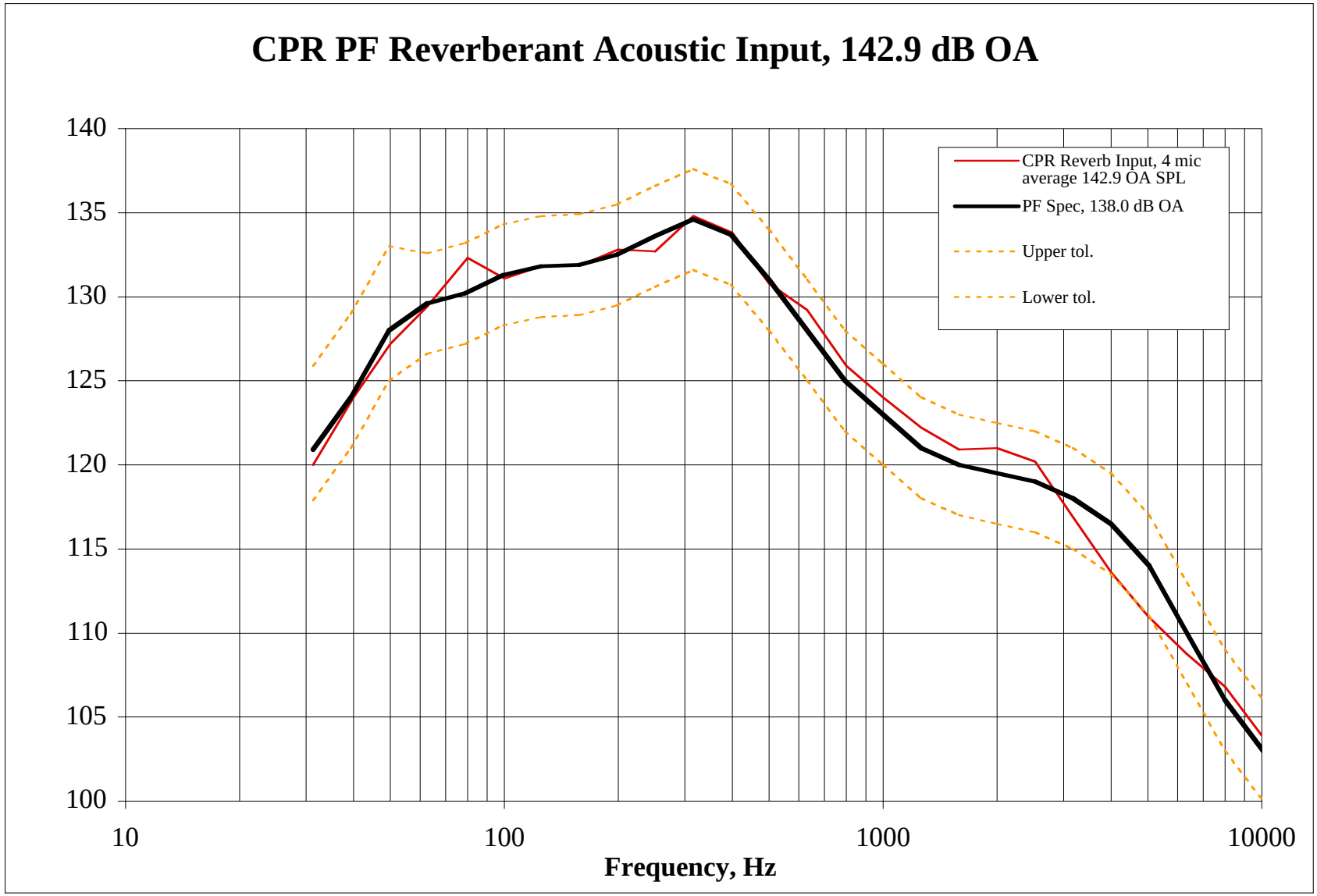
# M2 Reflector Accelerometer Locations



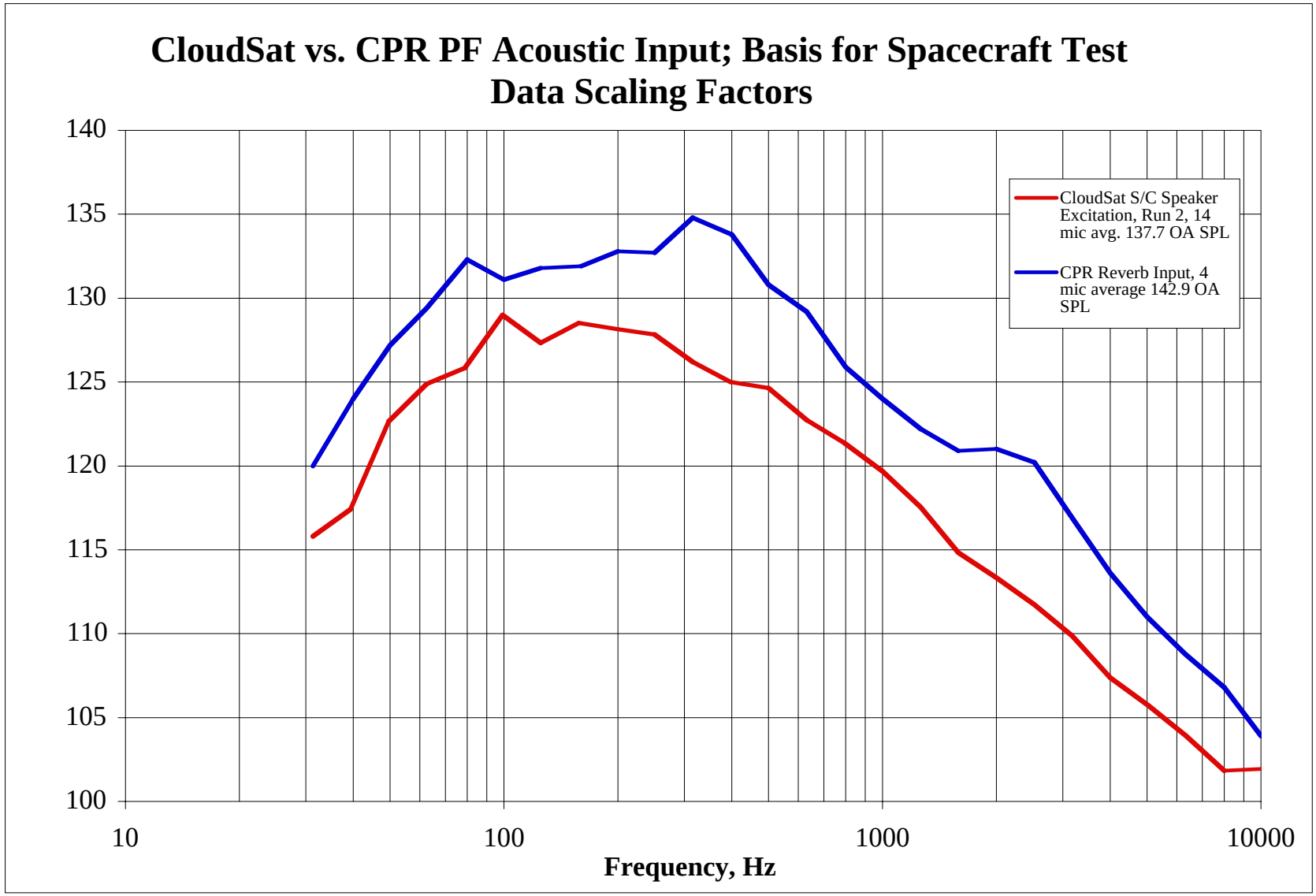
# Spacecraft Acoustic Input, Run 2 of 3, 137.9 dB OA



# CPR Structure Acoustic Input, 4 mic Average

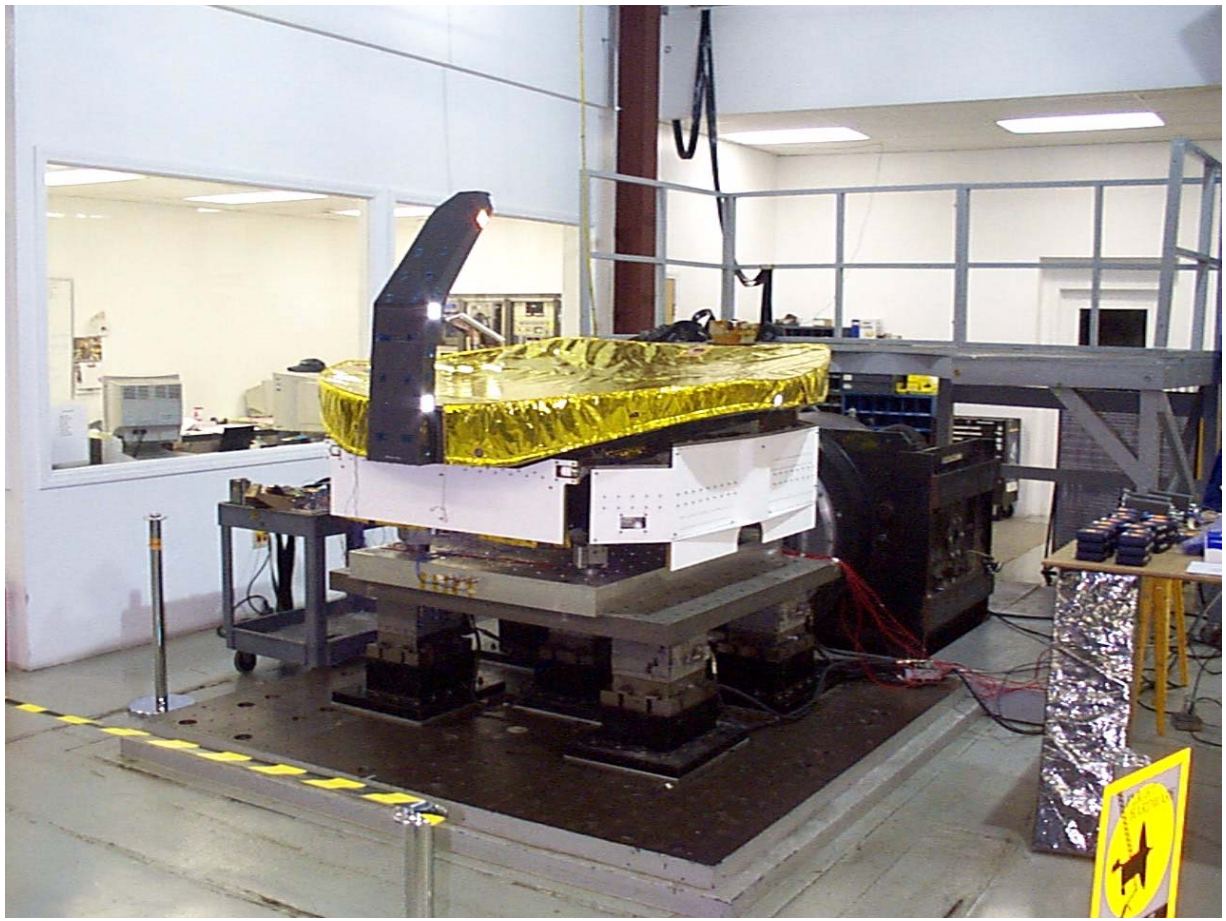


# Acoustic Input Comparison



# Cloud Profiling Radar (CPR) Configuration

- CPR Structure on shaker to show configuration
- CPR on transportation fixture for reverberent acoustic test (no picture)

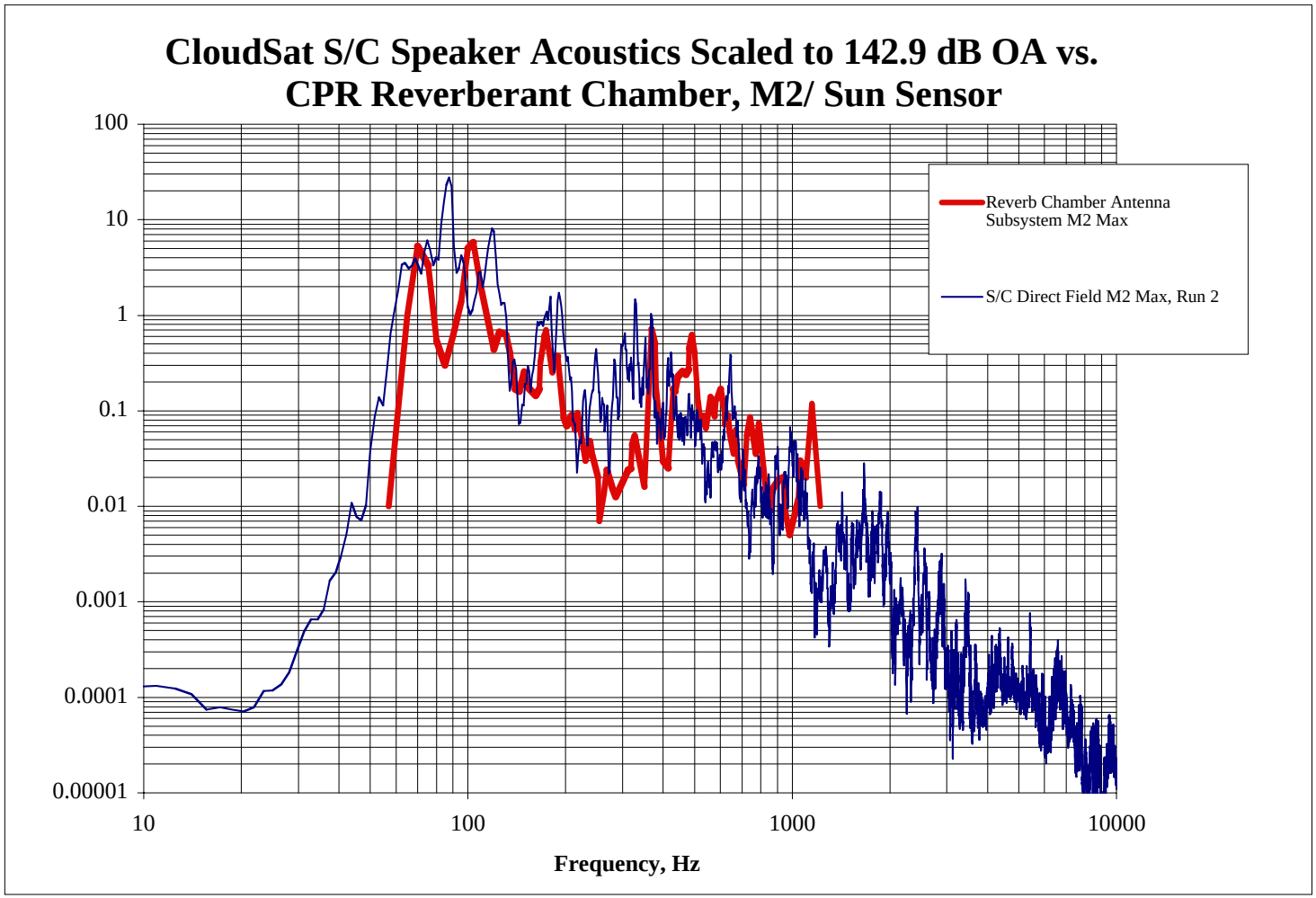


# CloudSat Speaker Acoustic Test Setup

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

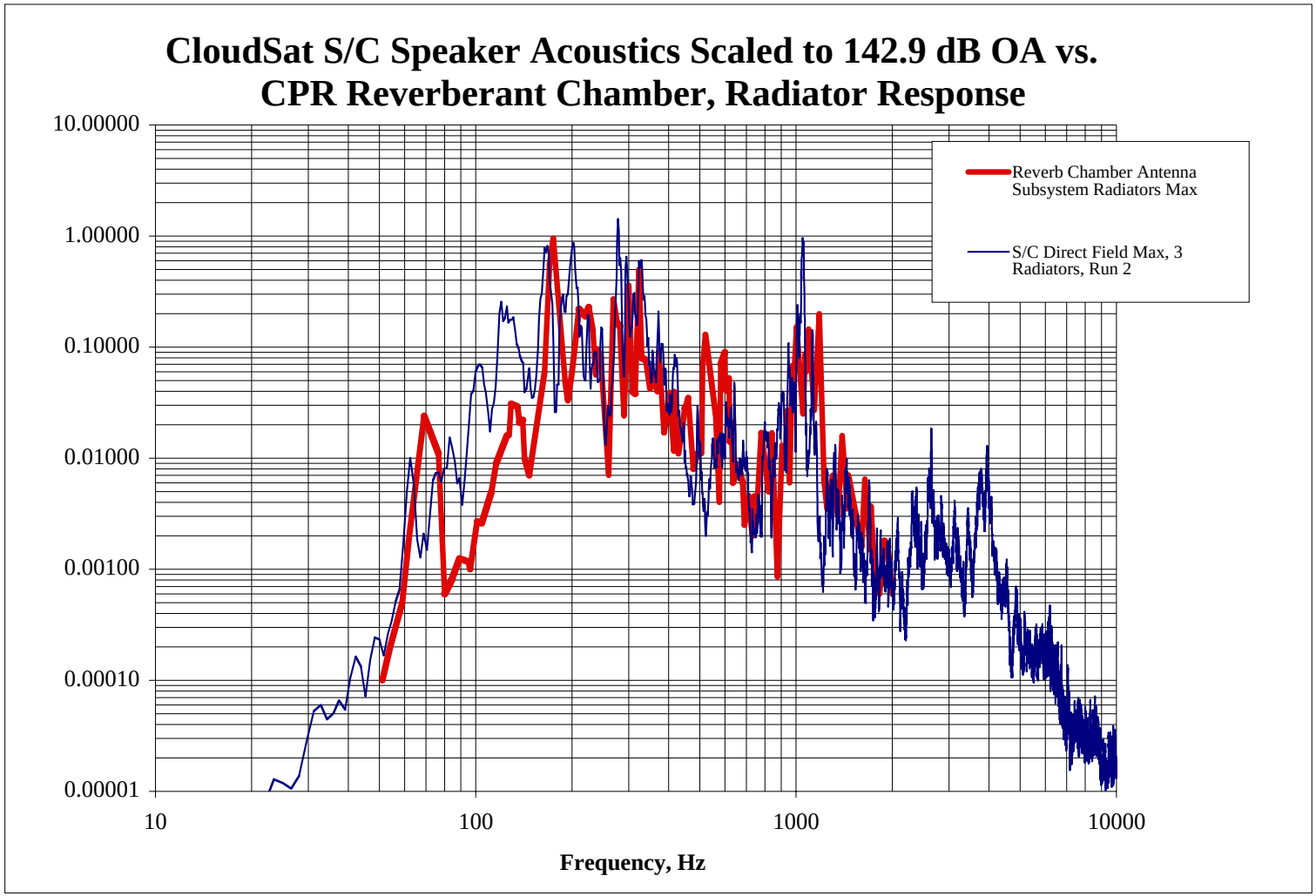
# M2 Reflector Response Comparison

- Reverberant and direct acoustic speaker tests resulted in similar vibration responses
- M2 speaker acoustic test responses were higher below 350 Hz, M2 attached to edge of main reflector which was in plane of sound source



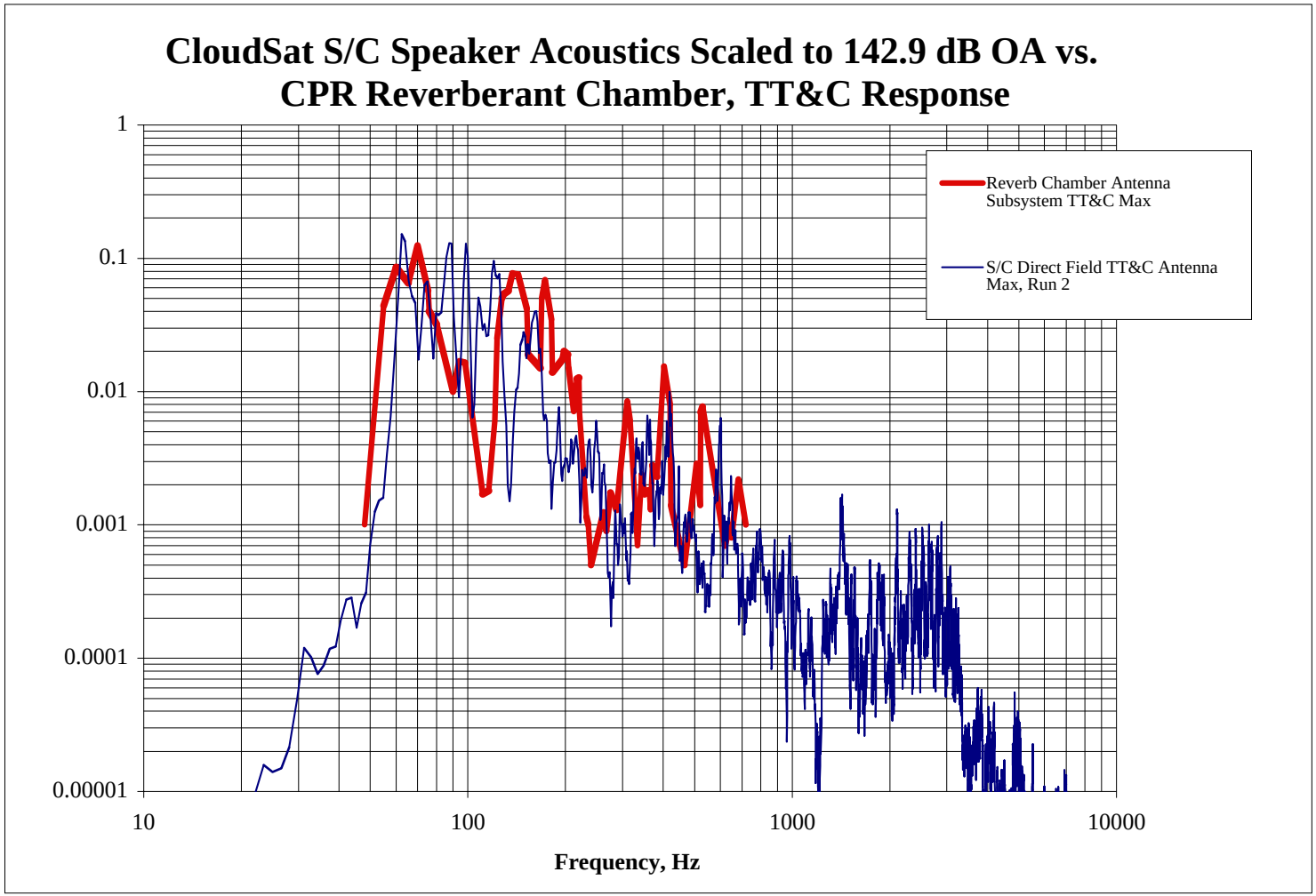
# Radiator Response Comparison

- Reverberant and direct acoustic speaker tests resulted in similar vibration responses except between 80 Hz and 150 Hz - radiators normal to sound source



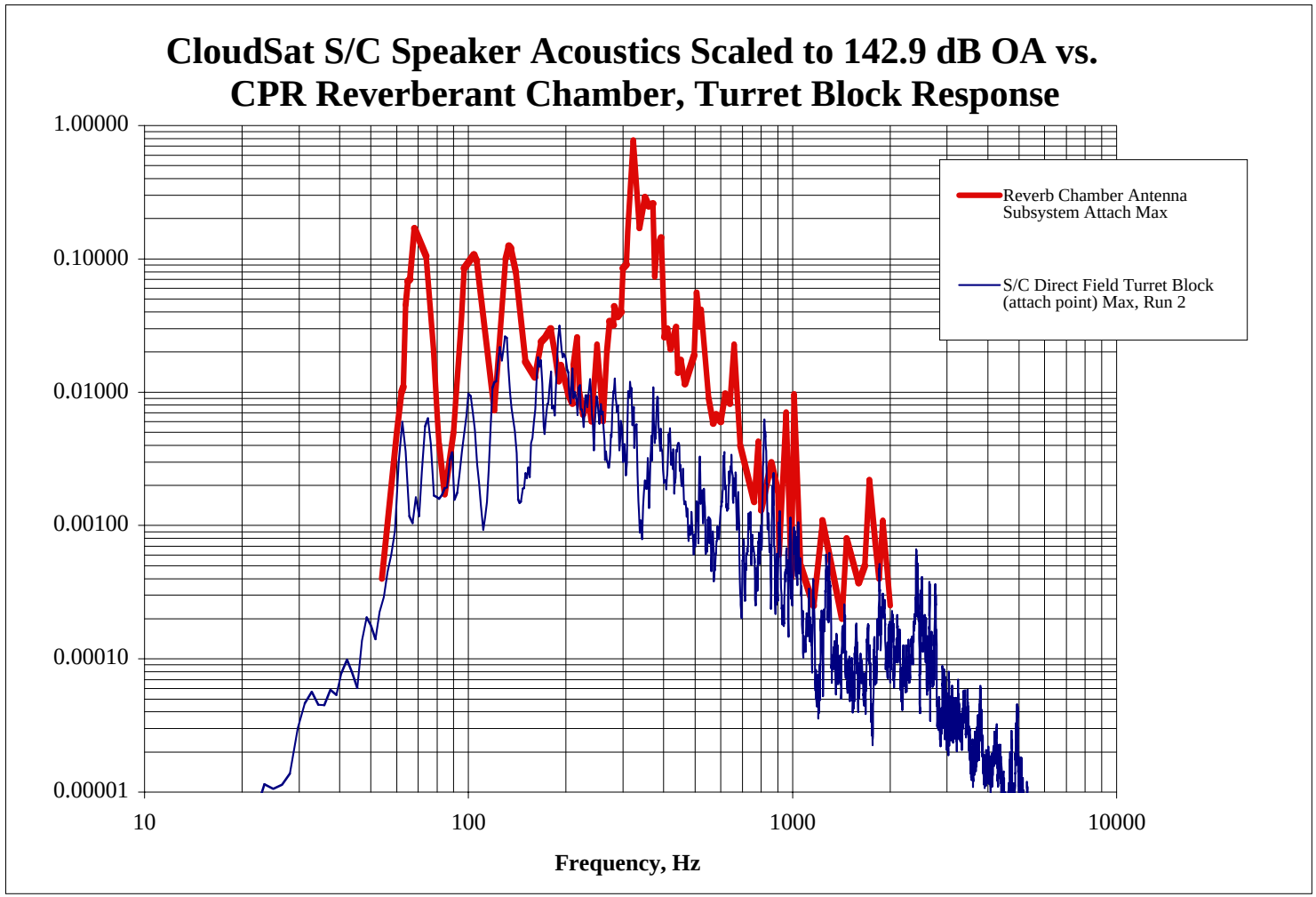
# TT&C Antenna Response Comparison

- Reverberant and direct acoustic speaker tests resulted in similar vibration responses except between 80 Hz and 120 Hz - TT&C excited by radiators/ structure sides normal to source



# CPR Mount Vibration Higher with Reverb Field

- CPR mount vibration significantly higher with reverberant field excitation
- Mass and impedance differ at CPR mount - spacecraft vs. transportation fixture



# Diffuse, Normal & Grazing Wave Test Efficiency

# Conclusions

- Reverberant and direct acoustic speaker tests resulted in similar vibration responses at common CPR instrumentation locations
- CPR speaker acoustic test responses were higher between 70 Hz and 350 Hz, depending on location
- Vibration at CPR interface was higher for reverberant acoustic test
  - Probably due to instrument boundary condition differences
- Future work; investigate cause of increased responses with BEM and SEA analysis