Overview

- PFM Test Results
  - Spectral Response Functions (SRFs)
  - Air Path Tests
- Forward Model Issues (mostly SRFs)
- In-Orbit Check-Out Activities
PFM Observations

- Signal-to-Noise
- Field-dependent Focus
- Fringes
- Asymmetries
- Temperature dependence, A/B, etc.
- Issues for In-Orbit Operation
Test Descriptions - All Spectral

Test 386: Minichamber, no-IS
Test 1191: Full Chamber, IS
Test 1249: Full Chamber, IS
Test 26x: Post-Vib, IS
Anomalous SRFs

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Field-Dependent Focus

Elevation = $-0.08 + 0.27 - 0.43$ degrees
Fringes from Summing SRFs

![Graph showing fringes from summing SRFs with data and model compared.](attachment:image.png)
Fringe Movement, Test-1191 to Test-1249
Fringe Movement with T Proportional to $\nu$

Test 1249 – Test 1191 Fringe Phase in cm$^{-1}$

Data
Data Corrected
Fit
Fit Corrected

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Test-386 M1a,M12 S/N
Test-261 M1a,M12 S/N
IS vs non-IS Test SRF Shapes, M1a
IS vs non-IS Test SRF Shapes, M12

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Widths, Centroids Variation with A/B Side

![Graph showing width and centroid variation with wavenumber.](graph.png)

- Test 263: B-side
- Test 262: A-side

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Pre-Vibration Test vs Post-Vibration Test SRFs

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SRF Asymmetries (vary with focus)
AIR-Gap CO$_2$, Optimal SRF Width = 0.987 * Test 261

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650 655 660 665 670 675 680
650 655 660 665 670 675 680
Wavenumber (cm$^{-1}$)

Transmission

Fit
Data

Obs − Calc T

x 10$^{-3}$

-5 0 5
-5 0 5
AIR-Gap $\text{H}_2\text{O}$, Optimal SRF Width = 1.009 * Test 261
SRF Modelling

- Compute simulated SRFs to test ability to retrieve
  - Include noise as measured (Test 261)
  - Include filter fringes, either EM filters, or M4d if not measured
  - Prove that observed centroid/width variations are due to filter fringers
- Model sensitivity to low-level wing
- Look-up tables vs model fitting for SRFs
Test 261 SRF Simulation Results

![Graph showing simulation results vs wavenumber](image)

- Δν in % of Width
- % Δ of Width
- Wavenumber (cm⁻¹)
Test 261 SRF Simulation, No Noise or Fringes

![Graph showing % Δ of Width and Δν in % of Width vs. Wavenumber (cm⁻¹)]
Test 261 SRF Simulation, With Noise, No Fringes

![Graph showing % Δ of Width and Δν in % of Width versus Wavenumber (cm⁻¹). The graph compares Test 261 and Simulation data.]
Test 261 SRF Simulation, No Noise, With Fringes
Test 261 SRF Simulation, M1b, EM-Filter

The diagram shows the comparison between Test 261 and Simulation for % Δ of Width and Δν in % of Width across different wavenumbers (cm⁻¹).
Test 261 SRF Simulation, M2b, Fake-Filter

![Graph showing % Δ of Width and Δ v in % of Width vs. Wavenumber (cm⁻¹)]

- % Δ of Width
- Δ v in % of Width
- Wavenumber (cm⁻¹)
Test 261 SRF Simulation, M4a, EM-Filter

% Δ of Width

Δν in % of Width

Wavenumber (cm⁻¹)
Test 261 SRF Simulation, M4b, EM-Filter

% Δ of Width

Δ ν in % of Width

Wavenumber (cm⁻¹)
Test 261 SRF Simulation, M4c, EM-Filter

![Graph showing % Δ of Width and Δν in % of Width vs Wavenumber (cm⁻¹)]
Test 261 SRF Simulation, M4d, EM-Filter

The diagram shows the % Δ of Width and Δν in % of Width as a function of Wavenumber (cm⁻¹) for Test 261 and Simulation. The x-axis represents the wavenumber ranging from 1220 to 1270 cm⁻¹, while the y-axis shows the % Δ of Width and Δν in % of Width. The data points are represented by blue and red circles, with blue indicating Test 261 and red indicating Simulation. The graph highlights variations and similarities between the two sets of data across the wavenumber spectrum.
Test 261 SRF Simulation, M5, Fake-Filter

![Graph showing % Δ of Width vs Wavenumber (cm⁻¹)](image)

- % Δ of Width
- Wavenumber (cm⁻¹)

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Test 261 SRF Simulation, M7, EM-Filter

Δν in % of Width vs. Wavenumber (cm⁻¹)

% Δ of Width vs. Wavenumber (cm⁻¹)
Test 261 SRF Simulation, M8, EM-Filter

Wavenumber (cm\(^{-1}\))

\(\Delta \nu\) in % of Width

% \(\Delta\) of Width
Test 261 SRF Simulation, M11, Fake-Filter
Nominal B(T) Sensitivity to Widths, Centroids

![Graph showing the sensitivity of B(T) to widths and centroids. The x-axis represents wavenumber (cm⁻¹), the y-axis represents B(T) in K, and the graph illustrates the error due to 5% width error and 1% ν error.]
B(T) Errors from T261 Simulation

![Graph showing B(T) errors from T261 simulation. The graph plots B(T) in K against wavenumber (cm⁻¹). The B(T) values range from 220 to 300 K, and the wavenumber range is from 1000 to 2500 cm⁻¹. The error in B(T) is also shown, ranging from -1 to 1.](image-url)
B(T) Errors, T261 Sim.: with Noise, no Fringes

![Graph showing B(T) errors with noise and no fringes.](image-url)

- B(T) in K
- Error in B(T)
- Wavenumber (cm⁻¹)
B(T) Errors using Raw SRFs vs Model Fitted to SRFs
Model Shapes to Test Sensitivity to SRF Wings

![Graph showing SRF sensitivity](image)

- Nominal
- High
- Low
B(T) Errors for Model Wing Variations

![Graph showing B(T) errors for model wing variations.](image)
B(T) Errors for Model Wing Variations

![Graph showing B(T) in K vs. Wavenumber (cm⁻¹)]

- **B(T) in K**
- **Error in B(T)**
- **Wavenumber (cm⁻¹)**

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B(T) Errors for Model Wing Variations

![B(T) Errors for Model Wing Variations](image_url)
Effect of Bruker on AIRS SRF

![Graph showing SRF error in % of Peak=1 vs. Point #, 0.053 cm\(^{-1}/pt\) for M1a, M2b, M4d, and M12.]
SRF Errors - Conclusions

- Field-dependent focus error is large (HHA analysis)
- Our simulation implies SRF errors of $\approx 2\%$ due to noise, fringes. (Simulation somewhat bogus since used known shape to fit data, real case could be worse).
- Bruker modifies SRF, 1% SRF error, correctable?
- Asymmetries, probably small, but very focus dependent, maybe a 1% SRF error.
- Error budget for placing SRF centroids at calibration centroids in orbit and bringing AIRS back in focus, maybe 1-2%?
Recommendations

- Reduce field dependent focus.
- Reduce fringing. Then we can then improve SRF fits by averaging.
- Need more AIRS non-IS runs with flight configuration for wings of long-wave arrays.
- Fringes move with temperature differently than SRFs, need calibration at each actual operating temperature.
- Will need fast model available for 3 operating temperatures? Fast model varies with temperature of AIRS. Max allowable fringe shift is about 10% of period.
- May need to optimize Bruker spectral runs for higher S/N.
Forward Model Progress

- New line-by-line code still under development. CO$_2$ P/R branch line mixing at 4.3 and 15 $\mu m$. Test with HIS, NAST, AERI, Scanning-HIS, INTESA.

- RAL CO$_2$ data now under analysis. Some preliminary results.

- Continued comparisons to ER-2 radiance data for CO$_2$ lineshape.

- RAL H$_2$O data will be analyzed soon.
Fast Model Production Flow

- HITRAN 9X
- Line Shapes Continuum
- Custom LBL
- GENLN2
- Monochromatic Abs. Coeffs (k)
- SVD Compression
- kCompressed Database
- kCARTA
- Layer-to-Space Transmittances
- SRF Convolutions
- Profiles
- Fast Model Radiative Transfer
- Fast Model Parameters
- Fast Model Regressions
- Radiances
- Convolved Transmittances
- Layers
- Retrieval

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Fast Model Fitting Errors

RMS Error in B(T) in K

Number of Channels

0 0.05 0.1 0.15 0.2 0.25
0 10 100 1000

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RAL Preliminary Results, 15 \( \mu m \) \( \text{CO}_2 \)
ER-2 Validation Spectra Comparisons

![Graph showing comparisons of observed and calculated B(T) values.]

WINTEX/NAST (solid), CIREX (o), CAMEX-2/HIS (+)

Obs - Calc B(T)

Wavenumber (cm⁻¹)

Cousin (GENLN2)
P/R Branch Mixing
ER-2 Validation Spectra Comparisons

[Graph showing Obs-Calc B(T) vs. Wavenumber (cm⁻¹) with different data sets represented by various markers and line styles.

Legend:
- Red: Cousin (Wintex/NAST)
- Blue: P/R Mixing (Wintex/NAST)
- Red Circle: Cousin (CIREX)
- Blue Circle: P/R Mixing (CIREX)
- Red Plus: Cousin (CAMEX/HIS)
- Blue Plus: P/R Mixing (CAMEX/HIS)
RAL Water Spectra

RAL data: h2oc file #4
filename: WVAC4S
Glab
ppart=13.1711 torr
ptot=413.179 torr
temp=293.9757
l=256.746 m

Glab − spectrum
filename: WVFC1B
filename: WVFC2B
filename: WVFC3B

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RAL Water Spectra
Future Work

- SRF analysis, 150/155/160K
- Generate new fast model with new nominal SRFs? If start August 1 can deliver by mid- to late-October, no new spectroscopy. Will miss August deadline for next fast model.
- Analyze RAL lab spectra and finalize CO\textsubscript{2} line-mixing parameters and H\textsubscript{2}O lineshape.
- Finish production of new kCARTA database. Add CO\textsubscript{2} and H\textsubscript{2}O when done.
- Inherit fast model code changes from JPL/GSFC back at UMBC.
- Examine statistical profile set for fast model regressions.
- kCARTA wrapper for AIRS In-Orbit check-out.
In-Orbit Check Out Activities

- Check earliest radiances for climatological reasonableness (bounds); need viewable spectra
- Spotcheck performance of fast forward model. Will we need a separate routine to compute radiances with fast model that is separate from the retrieval system.
- Use Goldberg’s HIRS-like retrievals to compute AIRS high-resolution radiances and compare.
- Examine early retrieval radiance residuals. Compare to channels not used in retrieval, especially those with similar weighting functions.
• Later on, look for interference by thin cirrus in 10 $\mu m$ window region.

• Provide estimates of how agreement between radiosonde water computed radiances and AIRS water channel radiances for higher altitude channels.

• Provide wrapper for kCARTA to use either AIRS retrievals or radiosonde reports.

• Provide layering code for radiosonde to AIRS stand-alone fast model, kCARTA? Much of our klayers integrated into the AIRS retrieval system.

• Need common way to get data (both http and ftp)

• Need Matlab on main JPL Team Leader machine.

• Need disk space at UMBC/Goddard, fast network speeds into JPL/Goddard.