S5 Spectral Line Catalogue Status

Keith Thorne (PSU)

for the

Spectral Line Catalogue Sub-Group

M. Landry, R. Schofield, B. O'Reilly, S. Klimenko, V. Mandic,

V. Dergachev, N. Fotopoulos, S. Waldman et.al.

LIGO-G060099-00-Z

Spectral Line Sub-Group

- Formed following the March 2005 LSC meeting
- Sub-Group charge includes
  - » Cataloging of spectral lines found by analysis teams
  - » Identify sources of these lines
  - » Work to remove most problematic ones
  - » Provide monitoring of lines to track progress, etc.
- Work supports efforts of commissioners, analysis groups (Pulsar, Burst, Stochastic)
- Regular reports to main DetChar group

S5 Spectral Line Web Pages

- Daily Line-Finding Reports (linked from S5 page)

https://gravity.psu.edu/~psurg/detchar/LineFinding/Daily_S5/S5_Linefind_Summary.html

  - » Automated daily processing on PSU grid computer
  - » Reports per-IFO lines found in science-mode data
  - » Daily reports have links, suggestions for SciMon investigations

- Main S5 Spectral Line Page

https://gravity.psu.edu/~psurg/detchar/LineFinding/S5_Spectral_Lines.html

  - » Has links to S5 investigations of Spectral-Line sub-group
    - – ***Send us information on investigations we have missed!***
  - » Links to results from previous runs, mechanical resonances

Line-Finder Improvements in S5

- Frequency range expanded to 40-1980 Hz
  - » Violin-mode harmonics now seen > 2 kHz
  - » ***Range can be expanded above 2 kHz (if there is interest)***
- Compares lines to list of previously-found lines
  - » Line tabulation color-coded to separate known from new
  - » Separate tabular report on new lines
  - » Includes line identification, if known
  - » Reference line list updated every 2-3 weeks
- Automated search for harmonic 'combs'
- Improved algorithm for close-lying lines (Feb 06)
  - » Now correctly finds most violin-mode lines

S5 Line Identifications

- H1 - Extended 60 Hz comb - Solved!
  - » Comb of harmonics (+ side-bands) extending past 2KHz
  - » Several investigation made but nothing conclusive
  - » Finally traced to poor RF distribution cabling - Fixed Feb 9, 2006 by R. Taylor, et.al.
- L1 - 12 Hz comb - Solved!
  - » Comb of 11-12 Hz harmonics up to 150 Hz
  - » Identified as “bounce-mode” - S. Waldman investigated causes
  - » Solved with new Beam-Splitter de-whitening board - Jan 21
- L1 - 38- 48 Hz Combs - Identified
  - » S. Waldman found strong coherence with optical levers
- Also see R. Schofield’s PEM injection report

Some Spectral Line Mysteries

- 329 Hz Lines (all IFOs)
  - » Strong enough that 2nd, 3rd harmonics seen
  - » Some speculative identifications (i.e. R. Adhikari - BS Violin Modes)
- 646-648 Hz Lines (all IFOs)
  - » 2nd, 3rd Harmonics often seen
  - » Coherences in other interferometer channels
- 546,566 Hz Lines (H1 only)
  - » Again, 2nd, 3rd harmonics often seen
  - » Coherent with some WFS channels
- 2.60, 2.64 Hz combs (H2 only)
  - » Extend from 40-100 Hz
  - » Seen in ETMX, ETMY shadow sensors

More Spectral Line Mysteries

- 600 Hz Line (H2 Only)
  - » Other 60Hz harmonics die out by 300 Hz
- Broad feature near 1620 Hz (H2 Only)
  - » Wanders from 1600 - 1650 Hz
  - » Can be problematic for Photon Calibrator measurement
  - » Some investigation
- 960 Hz Line (L1 Only)
  - » Both a narrow line (like 1921 Hz feature) and a broader line
  - » Other 60 Hz harmonics die out by 240-300 Hz
- Narrow 1921 Hz Line (L1 Only)

Filters for Spectral-Line Removal

- Linear Predictor Filters (S. Chatterji, et.al.)
  - » Used in some Burst Searches (WaveBurst, CorrPower, Q Pipeline)
  - » Can propagate glitches to adjoining time segments
- Regression Filters (PSU group)
  - » Uses auxiliary channel to create filters
  - » Works great on injections (calibration lines, photon calibrator)
  - » ***Does NOT work well for power-line harmonics in DARM_ERR***
- Kalman Line Filters (PSU group)
  - » Developed for filtering violin-mode resonances
  - » Now used (S5) to reduce power-line harmonics for BlockNormal
  - » ***Now testing automated line-finder+Kalman filter on network analysis pipeline (M. Rakmanhov)***

Further Plans for S5

- Support upcoming commissioning work at LLO
- Produce spectral-line lists for S5 epochs
  - » Used by Pulsar group, but only for lines with identified causes
- Document line-finder software package
  - » Can be used on arbitrary channels
- Release Kalman-based line-removal filter software
- If desired, create quick-turnaround line-finder for commissioning, SciMons