PDV analysis with SIRHEN 2.0

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What is SIRHEN 2.0?

- Sandia InfraRed HeterdynE aNalysis program
  - Part of the Sandia Matlab AnalysiS Hierarchy (SMASH) toolbox
  - Beta version available for government users
  - Open-source release later this year
- What's new?
  - Completely revised graphical interface
  - Multi-signal analysis of a common velocity
  - Dynamic uncertainty estimation
  - Bounce management
  - Much more…

Loading data

- Text files and binary file support
  - Agilent/Keysight, Tektronix, LeCroy, Yokogawa
  - Lab formats: DIG, PFF, SDA
- Raw signal no longer displayed by default
  - Large memory overhead
  - Not particularly useful in frequency shifted measurements
- Spectrograms are for your benefit only
  - History calculations are entirely separate
  - Avoids gigapixel/terapixel images

Measurement tab

- Distinct measurements of the same velocity are allowed
  - Separate wavelengths (1550/1064 nm) and offsets
  - Dissimilar bandwidths
- Channel settings table can be directly edited
  - Wavelength, offset, bandwidth, window correction
- Channel actions launched with a double click
  - Shift/scale time base (separate or linked)
  - Crop data (linked)
  - Calculate offset (separate or linked)

Analysis tab

- FFT options
  - Window type, number of frequencies, negative frequency display
- Partition settings
  - Duration/advance (time units)
  - Points/skip (used internally)
  - Blocks/overlap (sometimes convenient)
- Actions
  - Update spectrograms (not automatic!)
  - ROI, reference region, and generate history
- View results

Region selections

- ROI(s) restrict allowed time/frequency range
  - Variable width now supported!
  - Flexible point selection and editing
  - Multiple regions can be selected

- Reference selection used to determine noise spectrum
  - Select a time range where nothing changes
  - Uncertainty calculations based on this region

History analysis

- Power spectrum analysis is currently the only type available
  - No adjustable options at this time
  - Warning shown when no ROI selected

- Setting changes make results obsolete
  - Still available for display

- Uncertainty estimates account for **random** effects only

Viewing results

- Options
  - Velocity, uncertainty, and effective signal amplitude
  - Velocity and uncertainty only
  - Effective signal amplitude only
  - Velocity history overlaid on spectrogram
- Note: infinite uncertainties are permitted
  - Appear as missing data in the plot
- Tabs show all history settings
  - Where data came from
  - Analysis parameters

Saving your work

- Session files (*.sda)
  - Results can be loaded back into the SIRHEN
  - Contains everything: signal data, spectrograms, settings
  - Adjustable compression level
- Export files (text)
  - Extracted history with configuration header
  - Full/compact format
- PDV class objects
  - These objects can be saved to the workspace or loaded from the workspace

PDV objects

- All SIRHEN features are tied to a custom object class
  - Part of the Velocimetry package

- These objects can be saved to the workspace or loaded from the workspace

Summary and future work

- SIRHEN2 is out for beta testing
    - Most previous features carried over
    - Lots of enhancements
    - There are certainly bugs and unexpected behaviors

- New analysis techniques under development
    - Sinusoid fitting
    - Complex (real + imaginary) spectral analysis

Bonus round

- Measurements that bounce can benefit from negative frequencies
  - FFT options
  - Enable **before** calculating offset frequency
    - Values outside the bandwidth may be specified manually (leapfrog)
  - Work through bounces with ROI selection
  - Multiple signals may be needed to resolve bounces, particular for shocks