



MAST
Users
Group
Meeting

Nov 18
2013

Enhancing HST Spectral Products

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&

“HST Spectroscopic Legacy Working Group”



Introducing the

“HST Spectroscopic Legacy Working Group”

- The HSLWG was formed to study the recommendations stemming from the “Enhancing the Legacy of HST Spectroscopy” Workshop held at STScI on Nov 15-16, 2012.
- Primary Goals of the HSLWG:
 - Optimize HST's impact on current and future spectroscopic research (both new and archival) by identifying the most productive and feasible (in both a technical and resources-required sense) archival improvements from the suggestions generated by the Workshop, for development and implementation within a 2 year horizon.
 - Ensure in the process that the HST final archive will have the quality, content, and tools to support needs of the science community until next UV/optical spectroscopic mission is launched, a decade or more in the future.



Overview of the Process

- Membership of the group is as follows:

<i>Alessandra Aloisi (chair)</i>	<i>Jerry Kriss</i>
<i>Azalee Bostroem</i>	<i>Cristina Oliveira</i>
<i>Ken Carpenter</i>	<i>Rachel Osten</i>
<i>Stefano Casertano (co-chair)</i>	<i>Lou Strolger</i>
<i>Scott Fleming</i>	<i>Jeff Valenti</i>
<i>Andrew Fox</i>	<i>Rick White</i>
- The HSLWG first identified the main threads from Workshop with an eye toward finding the most useful and feasible ones from among the large number of recommendations produced by the participants.
- 5 major areas of discussion were singled out and explored:
 - a. Combining spectra
 - b. Spectral tools that are already available but people are not aware of
 - c. (Extracting multi-object spectra automatically)
 - d. Extracting information from spectra
 - e. Target information and classification
- Final recommendations were presented to the HST Mission Office in July 2013.



Recommendations – Part 1

Identified following tasks as priorities for next ~ 2 years (ordered from highest to lowest priority):

1. Make combined 1D spectral products available and create the pipeline to do it (develop the equivalent of ASTRODRIZZLE for spectroscopy)
 - Should be done incrementally by increasing the difficulty/complexity of the 1D spectroscopic data that are handled by the combination process.
 - Several pipelines already exist (developed by individuals or science teams) and can be used to facilitate design and requirements for a more generic pipeline.
2. Visualization tools for spectra
 - Many tools with different functions already exist spread throughout MAST, HLA, and VO.
 - Purpose of this activity is to consolidate existing tools into the Archive Portal.
 - Tools will allow for a quick look and basic measurements of the spectroscopic data in the archive.



Recommendations – Part 2

3. Search tool to select sources based on their classification
 - Should be dynamic and integrated into the Archive Portal.
 - Classification could be done starting from HST program ID, PI keywords and abstract and evolving into something more sophisticated (e.g., catalog-based classification, crowd sourcing, etc.).
4. Tool for feature identification and measurement (develop the equivalent of a source extractor for spectra)
 - Relies on classification of spectroscopic sources for complete implementation.
 - May require multiple options to handle different types of data (emission/absorption, bands, forests; high S/N vs. low S/N; high z vs. low z, continuum structure).
 - Should be fully integrated into the Archive Portal.



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Requested Feedback

- Would you use the tools and the high-level spectral products that we are proposing to develop ? If so, how ?
- Do you agree with the priority list ?
- Is something major missing from our list ?
- Anything else that we should take into account?



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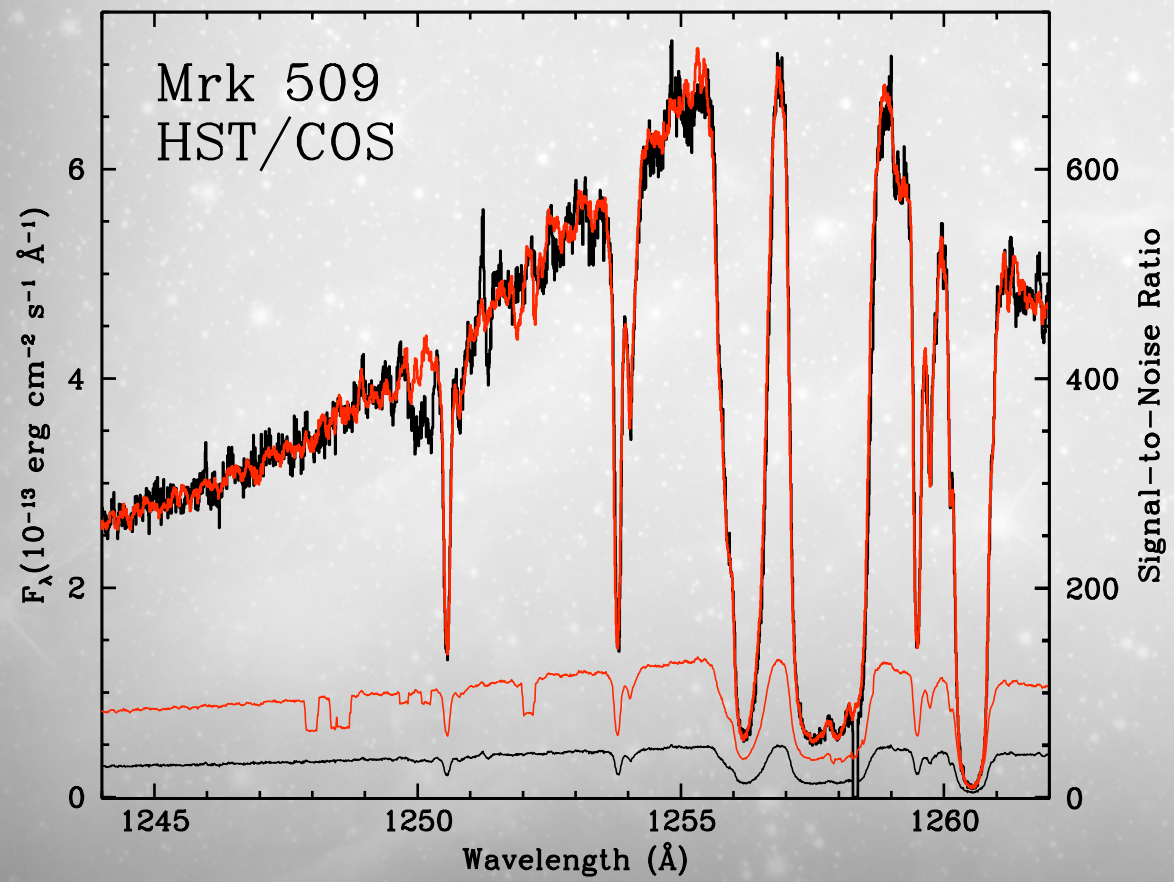
**Nov 18
2013**

Back-up Slides



1) Make Combined 1D Spectral Products Available and create the Pipeline to do it – Part 1

- Ultimate purpose of this activity is to combine 1D spectroscopic data together. In order to do so a spectroscopic pipeline is required.
- An example of the advantage of combining spectra taken with different COS settings is illustrated below.



Combined HST/COS spectrum of the Seyfert 1 galaxy Mrk 509 from Kriss et al. (2011, A&A, 534, 41). The black curve shows the single spectrum of one wavelength setting produced by the COS pipeline. The red curve shows the combined spectrum using all four central wavelength settings (this is not currently done by CALCOS). The thinner curves show the respective signal-to-noise ratios of the single spectrum and the combined spectrum.



1) Make Combined 1D Spectral Products Available and create the Pipeline to do it – Part 2

- High priority, but will require ~ 2 years
- Task should be done incrementally by increasing the difficulty/complexity of the 1D spectroscopic data that are handled by the combination process.
- Several pipelines already exist (developed by individuals or science teams) and can be used to facilitate design and requirements.
 - Typically existing pipelines are tailored to specific science goals.
 - A more general design is required.
 - The writing of the pipeline should be done in steps:
 - The tool can start as an off-line tool manually triggered to create new high-level products for our own HST data into the HLA. This will allow us to get something quickly and with high visibility.
 - It could evolve into part of the DMS processing.
 - Ultimately it could become a stand-alone tool offered to the community, similarly to an *ASTRODRIZZLE* for spectroscopy.

1) Make Combined 1D Spectral Products Available and create the Pipeline to do it – Part 3

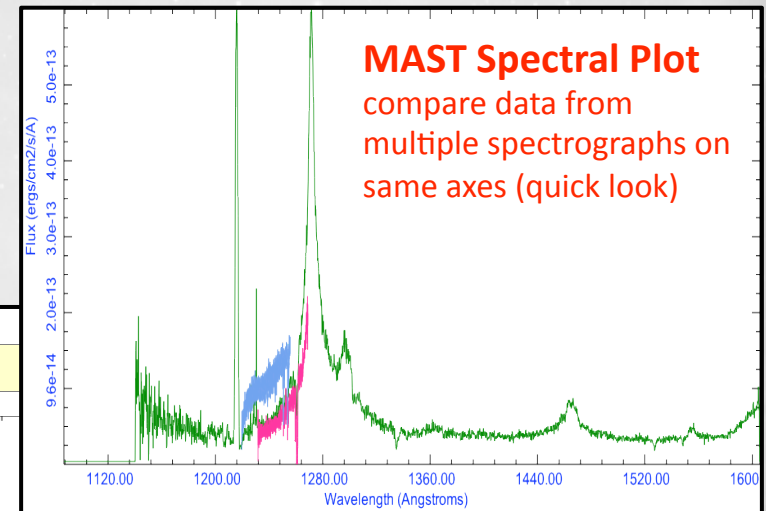
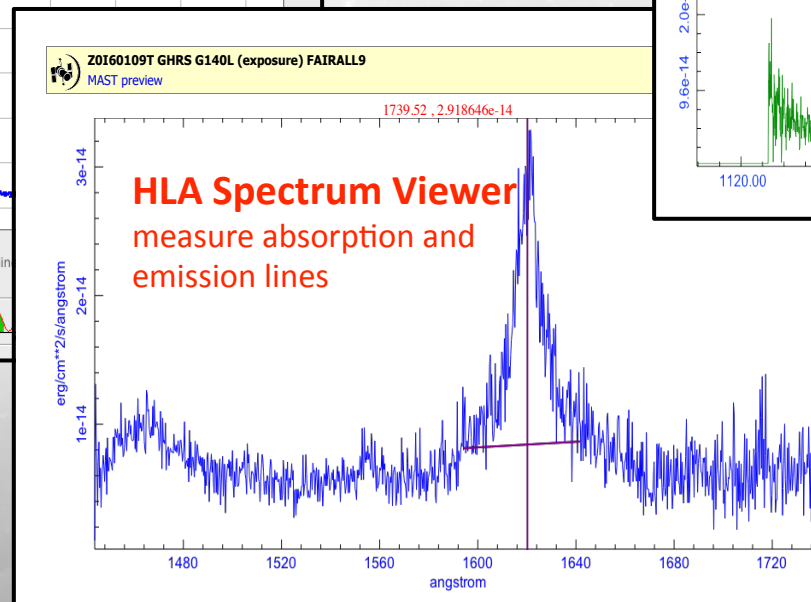
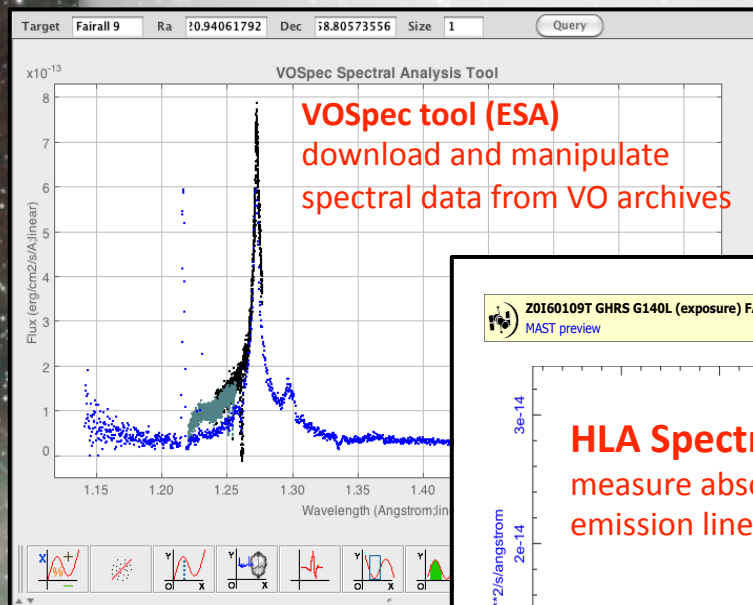
- For combination of 1D homogeneous data (HST similar instrument and resolution):
 - **Phase 1** (6 months, FY 2014-Q3,Q4): design and requirements
 - **Phase 2** (18 months, through FY 2016-Q2): development and testing
 - **Phase 3** (partially overlapping with Phase 2, continuing effort): implementation, data processing and ingestion
- For combination of heterogeneous data, add 50% or more
 - could be partly done in parallel
- For extended sources, the second dimension needs to be added (2D spectroscopy).





2) Visualization Tools for Spectra – Part 1

- Purpose of this activity is to consolidate the existing visualization tools for spectra into the Archive Portal.
- A lot of tools with different functions already exist spread throughout MAST, HLA, and VO (see figures below):
 - Existing tools are OK for a quick look and some basic measurements.
 - Existing tools need improvements to become more user friendly and for more in depth analysis.
 - Everything should be consolidated into the Portal.
 - Timeframe is driven by integration into the Portal.



Examples of Existing Visualization Software. HST spectra of QSO Fairall 9 are shown with three existing online tools. Tools and functionality need to be integrated into the Archive Portal and advertised.



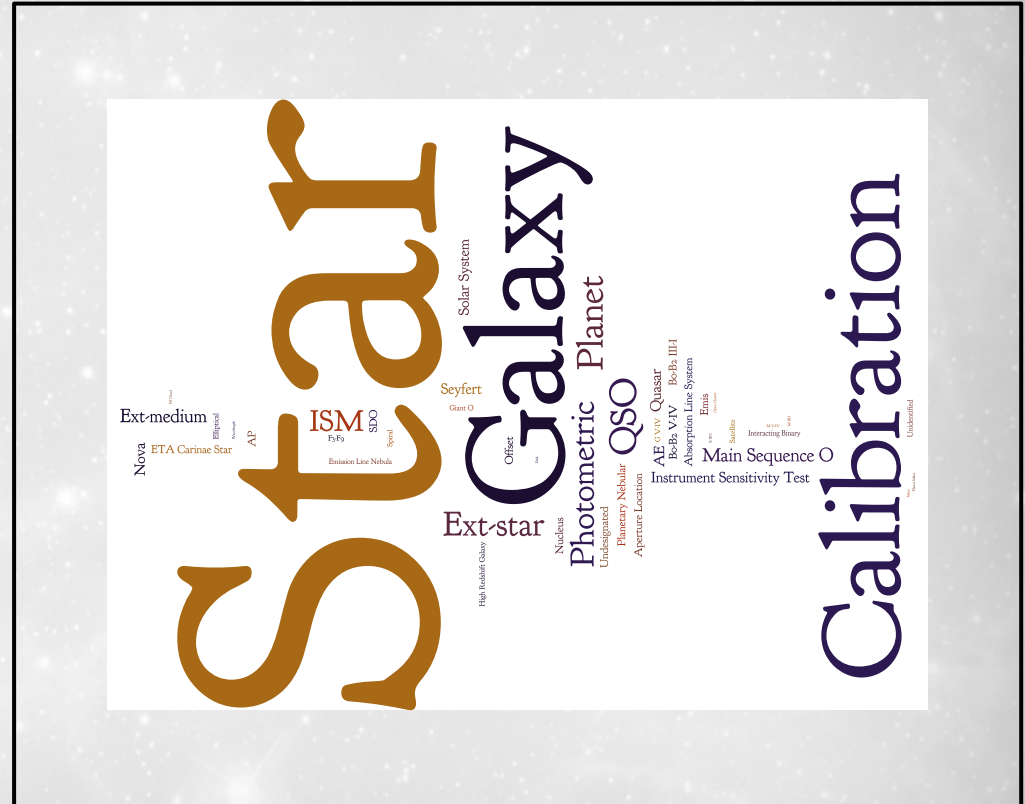
2) Visualization Tools for Spectra – Part 2

- Medium-high priority, mostly based on adaptation of existing tools.
- We envision all these tools as web-based.
- The tools will allow for a quick look and basic measurements of the spectroscopic data available in the archive.



3) Search Tool to select Sources based on their Classification – Part 1

- Main focus of this effort is creation of a dynamic search tool integrated into the Portal that will select targets based on some kind of classification of the sources.
 - applicable to all HST data (imaging and spectroscopy).
 - based on VO lexicon.
- Medium priority, may bring some results in less than a year.



Keywords used to describe the targets in the Phase II of the HST approved spectroscopic programs (COS, STIS, FOS, GHRS).



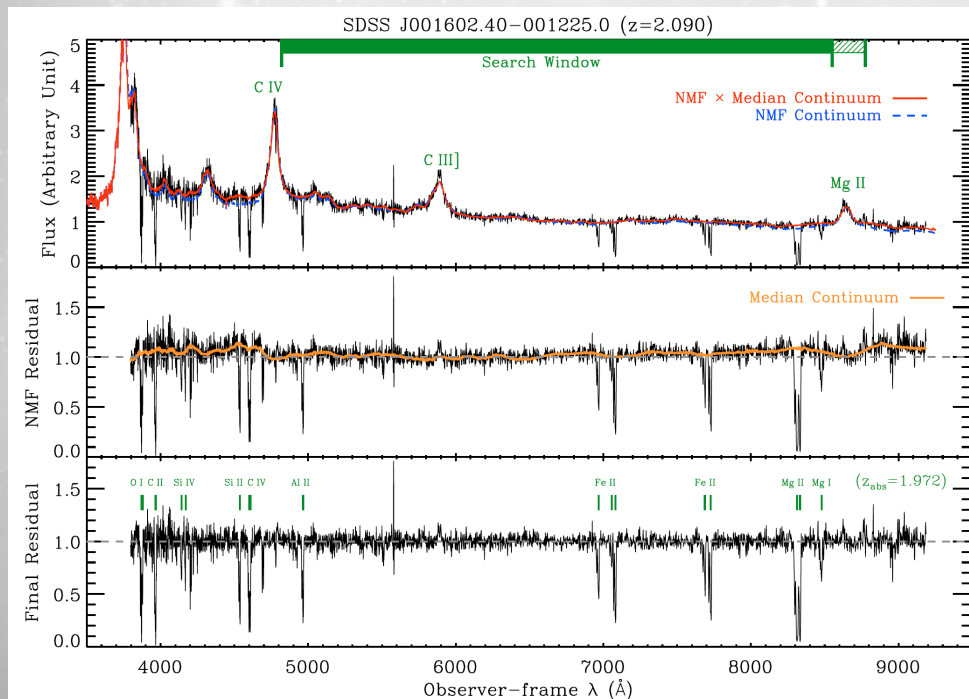
3) Search Tool to select Sources based on their Classification – Part 2

- Classification of sources could be approached in an incremental way:
 - HST program IDs (as well as PI keywords and proposal abstracts) already associated to literature.
 - Keywords could be easily extracted for each source in the program, even if this process is not quite rigorous and will result in some false positives.
 - HST datasets (in addition to program IDs, PI keywords, and abstract proposals) are currently being associated to literature.
 - This is an ongoing effort started a couple of years ago.
 - Large back-log (~ 11,000 papers) needs to be cleared.
 - Higher priority could be given to HST (COS, STIS, FOS, GHRS) spectroscopy (~3,100 papers).
 - Future developments could include catalog-based classification, crowd sourcing of the classification, better definition of the target keywords in the Phase II.

4) Tool for Feature Identification and Measurement (Develop the Equivalent of Source Extractor for Spectra)

Part 1

- Purpose of this activity is to develop tools that allow for feature identification and measurements on spectra.
 - Tools would be integrated into the Archive Portal.
- Medium priority, partly based on adaptation of existing tools.
- Similarly to what already done, e.g., for absorption lines in quasars of the SDSS (see figure below).



Automated fitting of quasar spectrum with automated detection of absorption lines illustrated in Fig. 1 from Zhu & Menard (2013, ApJ, 770, 130). The top panel shows the best fit nonnegative matrix factorization (NMF) quasar model from SDSS DR7 plotted on the observed spectrum. Dividing this out leaves a normalized spectrum with broad residual structures (2nd panel). Median filtering this spectrum produces the bottom panel, which is then searched automatically for absorption lines.



4) Tool for Feature Identification and Measurement (Develop the Equivalent of Source Extractor for Spectra)

Part 2

- May require multiple options to handle different types of data (emission/absorption, bands, forests; high S/N vs. low S/N; high z vs. low z , continuum structure).
 - task can be started any time, but relies on classification of the spectroscopic sources for complete implementation.
- Useful tool may be obtained in ~ 1 year.
- Effort currently budgeted in second year.



Other Areas of Possible Interest

- Multi-Object Spectral Extraction and Characterization (e.g., Grisms).
 - Not championed within working group.
 - May be best led by instrument teams (e.g., WFC3 + JWST instrument teams).
- Tools to visualize and analyze time dependence.
 - Common framework yet to be established.
- HST data in meta-catalogs.
 - E.g., NED does not show HST data consistently.