VUV/UV Transmission and Reflection Spectrophotometer
TR-SES 300

TR-SES-300 was developed for in-house testing of calibration light sources for the Hubble Space Telescope. We found that existing spectrometers tended to have long term stability issue, large footprints and old fashioned computer interfaces that were tacked onto systems with manual mechanical controls. Our spectrometers and light sources can operate on a desktop from a laptop PC. They are delivered with elegant stable computer interfaces that are readily modifiable and feature rich. Our systems are easy to install and use and do not require big vacuum chambers, large amounts of power, water cooling or cumbersome optical benches.

As a result of extensive experience in the VUV over a 30-year period our approach was to simplify the optical systems as much as possible to reduce risk of VUV contamination. TR-SES consequently has only two reflective surfaces in the VUV before the sample holder. In addition, our instruments use technology developed to provide stable calibration to space instruments with no possibility of repair. The deuterium lamp we employ does not have electrodes, which can sputter on the window and cause the shape of the spectrum to change. Instead it is powered by a miniature-radio-frequency power supply developed and used on the Wide Field Camera and Space Telescope Imaging Spectrograph. This air-cooled light source is highly stable and exhibits low noise and can be modulated for time decay measurements and phase sensitive detection. Unlike other Deuterium lamps it uses a chemical source of D2 similar to hydrogen storage technology used in fuel cells which gives is an exceptional operational life.

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Technical Data		
Wavelength Range	115 to 320 nm	Single lamp with automatic order=sorting filters
Spectral resolution	0.1 nm	FWHM of spectral line
Wavelength reproducibility	0.05 nm	Computer controlled and calibrated monochromator verified at 121.5 nm, 160 nm, 243 nm
Operation pressure	< 1 x 10^{-5} mbar	Whole system is only 25 liters resulting in pump down in 20 minutes when pumping is repeated. (first pump-down always takes longer owing to water vapor)
Accuracy of measurements Transmittance Mirror Reflectance	 0.25% 0.5% 0.5 % 1%	 In 200 to 300 nm range In 120 to 200 nm range In 200 to 300 nm range In 120 to 200 nm range
N2 Purge System	Standard feature	
Precision overall	0.25%	
Band pass adjustable	0.1 to 6 nm	Micrometer driven entrance and exit slits
Calibration accuracy	0.1 nm	
Wavelength reproducibility	0.05 nm	Constants held in computer
Measurement beam	Collimated	Off axis parabola
Detectors	Solar Blind CsTe PMT	Standard covers 115 to 320 NM
Optional second detector	Multi Alkali	Second detector mounting fixture standard but detector is optional and requires power supply
Beam size adjust	Iris is standard	
Normal reflectance angle	Mirror provided to remove detector blocking	+- 5 degrees standard , Narrower on request
Polarizer	Rochon prisim	Optional
Detector position	0 to 360 degrees	Computer controlled stepper standard
Sample holders	12 mm, 25 mm, 50 mm	16 samples, 10 samples and 5 samples, each with MgF2 window suitable for powder transmission /reflectance
Sample rotation	0 to 400 degrees	Computer controlled to better than 0. 1 degree
Sample tilt	+ - 90 degrees	Computer controlled to better than 0. 1 degree
Order sorter	4 positions PC controlled	Blocking for UV and visible with blanking for zero
Software/ A to D	A to D/ D to A control	Complete control and acquisition part of base price
Automatic sample control and measurement	Standard feature	Allows sequential measurement of up to 16 samples Table ID sample and PC positions and then saves data
Lamp modulation	Optional	System can measure phosphor decay
Photon counting	Optional	
Vacuum Pump	Standard	Turbo plus diaphragm pump air cooled
Power	100 to 120 V 10 Amps 220-240 V/5A	Mainly pump (without pump less than 2 A)
NIST intensity Cal	Optional	D2 Lamp has been used as NIST transfer standard by JPL

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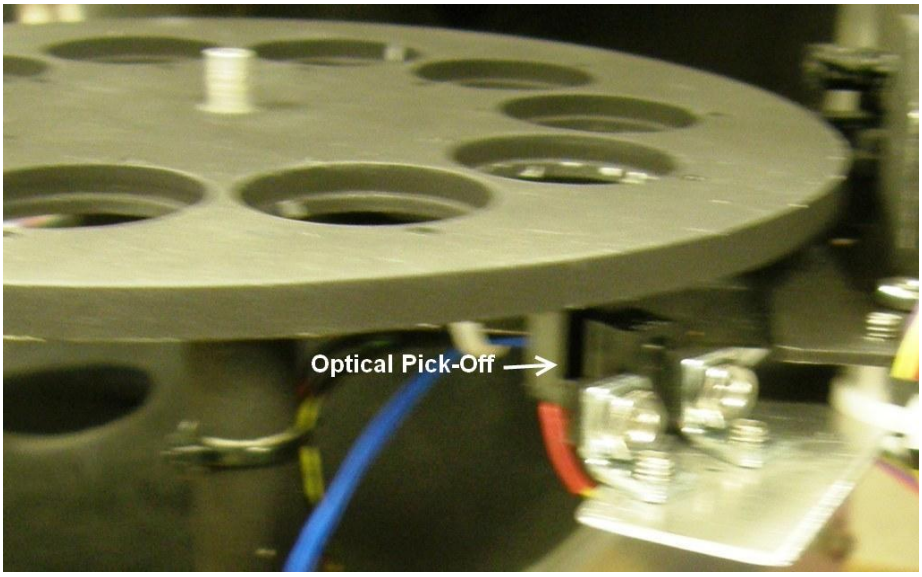
Features and Advantages of Resonance Vacuum Spectrophotometer (TR-SES) for Transmission and Reflectance Measurements

Feature 1: Rapid switching to open position for stable sample reference spectrum.

Since the Resonance D2 lamp is ultra stable in both short and long term this method of referencing overcomes the difficulty seen by competitors in dual beam systems, namely drift of the separate reference path relative to the sample path.

This is important since the traditional Dual beam approach (which uses special mirror systems) does not work well because of the susceptibility of additional surfaces to contaminating UV-attenuating films The sources of these films vary from room air deposits in the vacuum chamber to samples which off-gas in vacuum.

The figure below shows the light-weight sample holder that is powered with a small stepper motor. This whole assembly is on a yoke which can be tilted with a larger stepper motor attached to the door. Transit time from sample to sample is less than 2 seconds.



Feature 2: Automatic filter switch on monochromator switches through three overlapping spectral ranges and no-light reference.

Position 1: 115 to 230 NM (open filter)
Position 2: 160 to 320 NM (quartz filter)
Position 3: 290 to 545 NM (Borosilicate filter)
Position 4: Dark reference or optional: 500 to 1,000 NM

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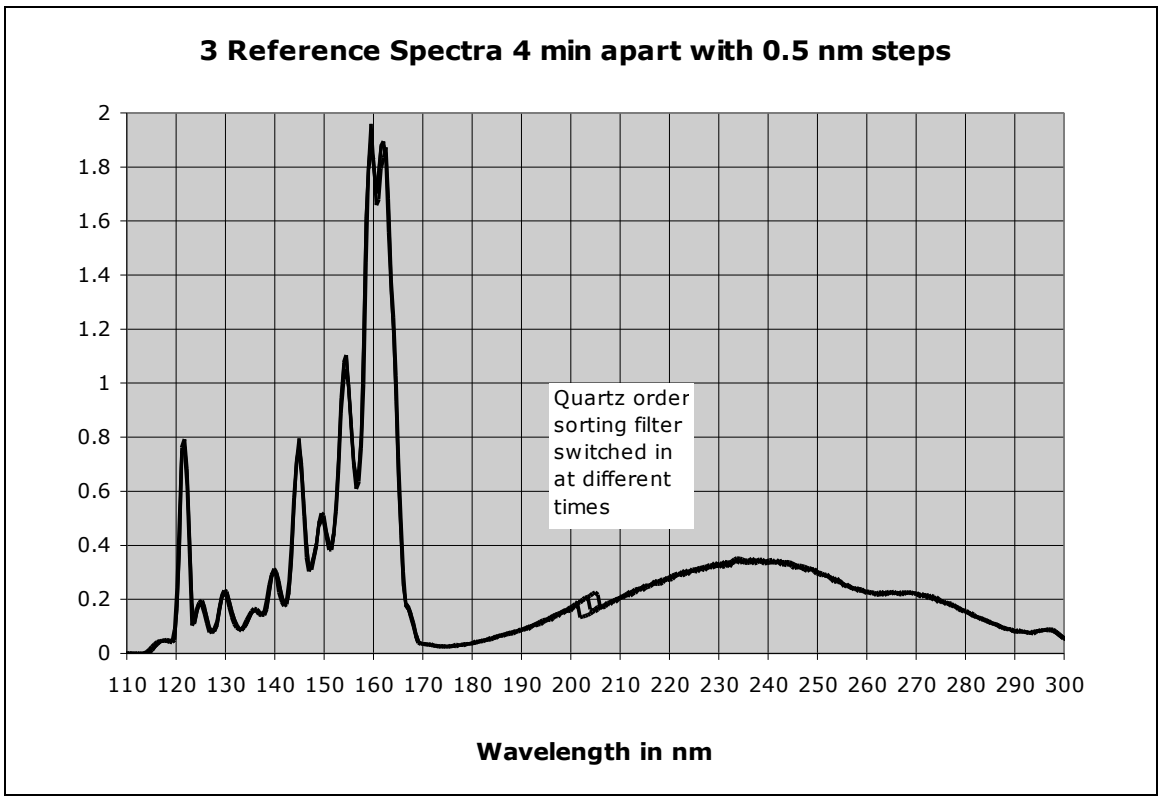
This enables the use of a single light source up to 320 nm or longer wavelength. A single light source eliminates variations between two light sources caused by drifting plasma and different rates of contamination.

Feature 3: High stability RF-lamp

1. No electrodes, no sputtering.
2. Source of D2 in the lamp (solid pellet) so lamp gas never changes
3. Lamp is close to entrance slit which eliminates extra optics for improved efficiency and lower drift. Efficiency significantly higher than competition which use mirrors (inverse square law)
4. Optional feature Lamp can be modulated for Phase sensitive detection
5. Overnight drift less than 2 percent above 125 nm



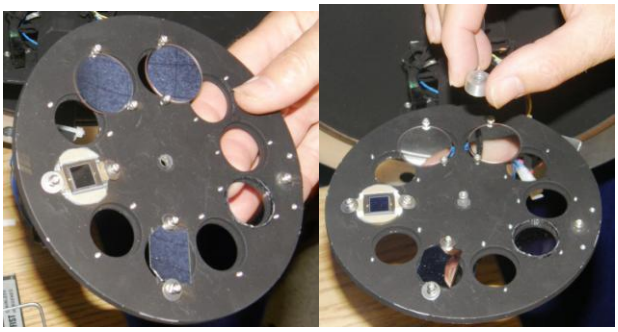
Feature 4: Interchangeable sample wheels automatically tilted and rotated

1. Sample angle calibration to number
2. Easy to switch wheels within 2 minutes
3 Wheels are horizontal in zero degree position making bare powder measurements possible
4. Standard sizes include:

Φ 12 mm x 16 positions.

Φ 25 mm x 10 positions.

Φ 50 mm x 5 positions.



Feature 5 Large dynamic range allows use with high reflectors and dark scatters

Dynamic range obtained 3 ways

1. Adjustable iris on monochromator output (factor of 50)
2. Adjustable entrance and exit slits (factor of 1000)
3. Adjustable PMT voltage (factor of 50)
4. Adjustable PMT amp gain (factor of 10)

Without changing lamp we can measure 100 percent mirror down to 10-6 percent absorbing surface.

Feature 6: Low volume monochromator and chamber reduce evacuation time

1. Use of tube design rather than inefficient box
2. Small turbo/dry scroll pump pumps out in 20 min to 10(-5) mbar
3. One button pumping no valves to open.
4. One valve venting with speed regulation to prevent pump damage

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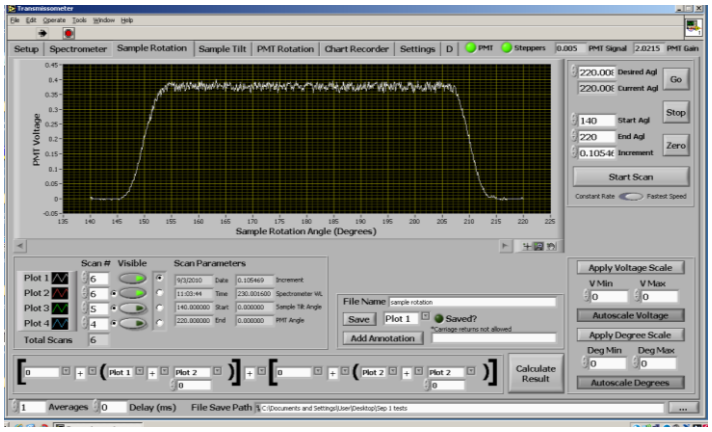
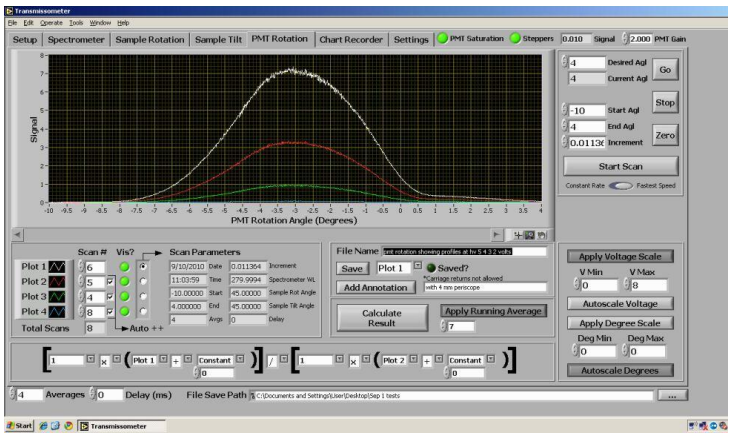
Feature 7: Easy sample interchange

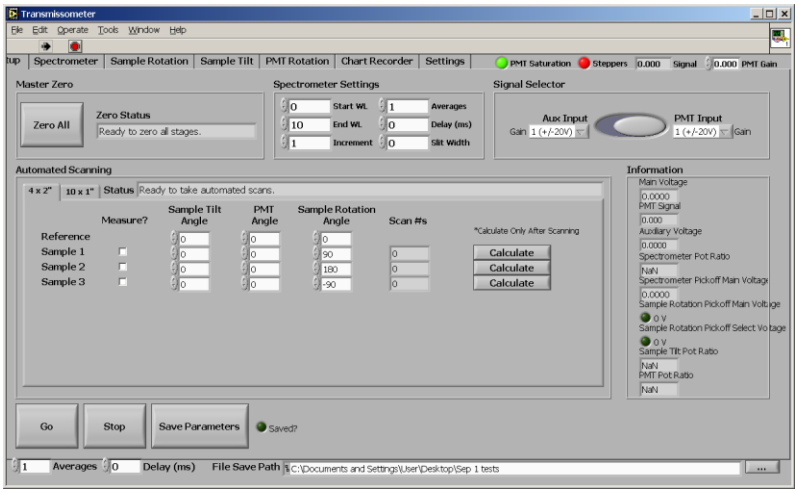
1. Sample door swings out exposing sample wheel for changing
2. Wheel can be put on in 30 seconds or less
3. Close door push one button to pump

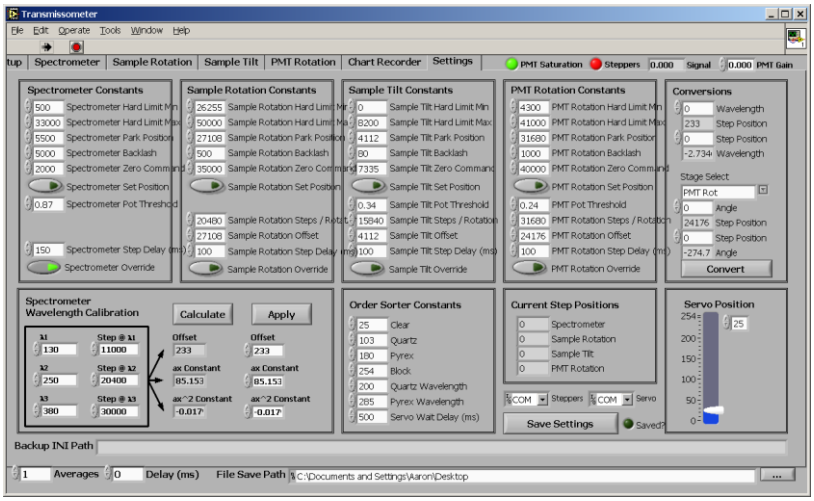
Feature 8: Software control of everything

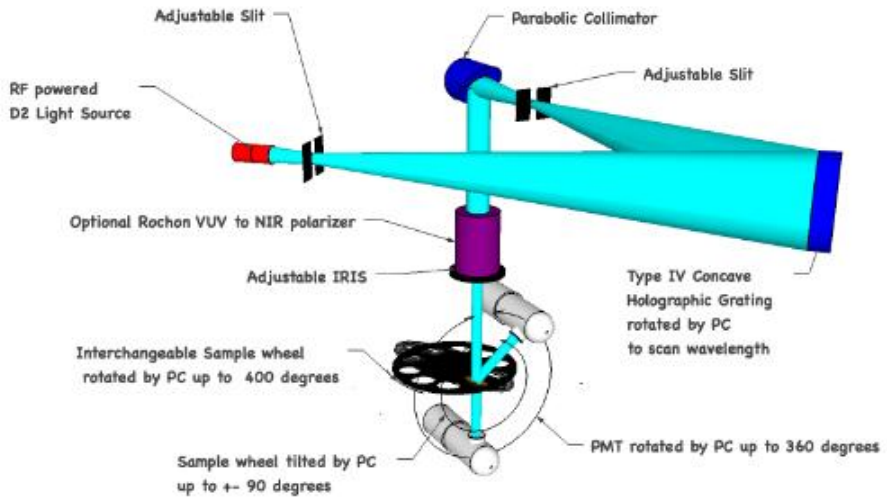
1. Software is stable
2. Software is up to date
3. Software is loaded and ready to run
4. Tabs for each feature
5. Auto modes for high throughput of sample
6. PMT voltage control with light detection prevents accidental destruction of pmt by exposing to room lights
7. Park positions on wheels prevent damage
8. Calibration in SW
9. Spectra Sample scanning for profiles in sample tilt PMT angle
10. PMT gain and amp gain adjustable in SW front panel
11. Up to 40 spectra saved in buffer for on screen data manipulation











Feature 9: Only 2 optical components between lamp and sample in VUV mode

1 Resonance addresses the MAIN problem with VUV spectrophotometers (contamination) with efficient optics
2 Optical component are as far away as possible from VUV light source.