Next Gen AERI System
Based on Spatial Heterodyne Spectrometry

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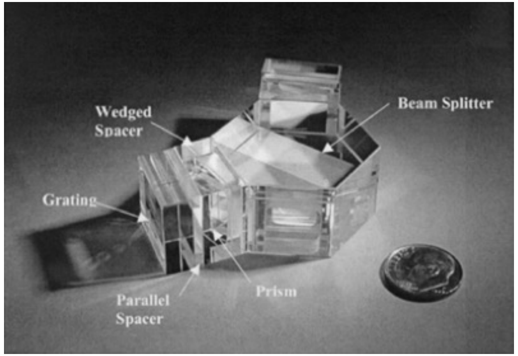
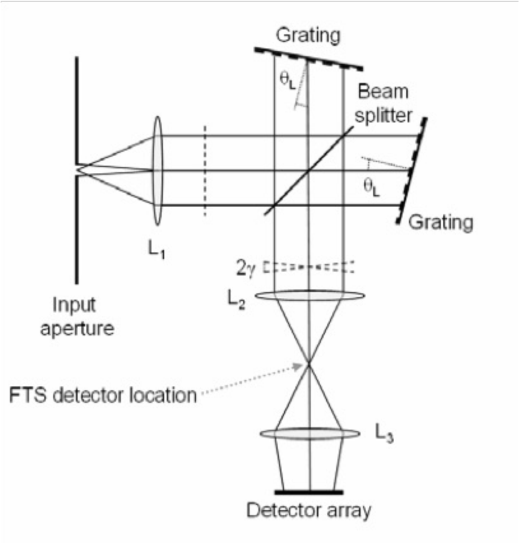
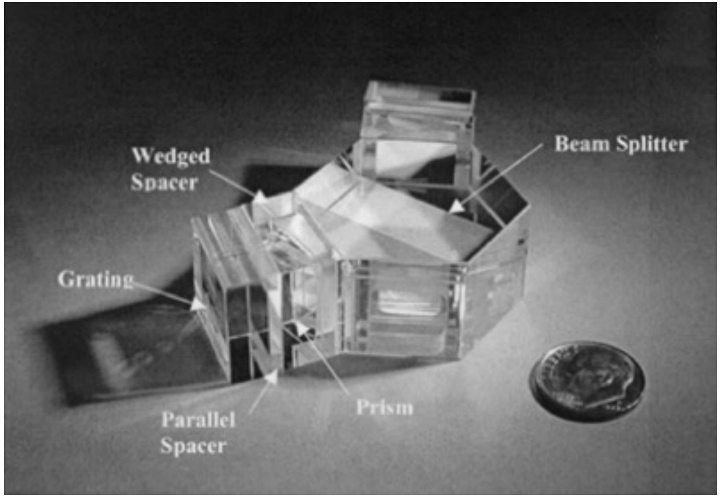


Next Gen SHS AERI Summary

- Uses spatial heterodyne spectrometry (SHS)
  - Developed at UW Physics in 1990s, local expertise
  - Combination of Fourier transform spectrometer with gratings
  - Uses position sensitive detector array instead of temporal image sampling in FTS / AERI
  - Mainly used in UV astronomy applications, minimal in IR
  - To measure downwelling spectral IR radiance, 715 – 790 cm^{-1}, 0.5 cm^{-1} resolution, for profiling temperature and water vapor
- Novel aspects:
  - Instrument hardware designed to optimally work with AERIoe retrieval
  - No precision moving parts, simple robust optical system
  - Smaller, simpler, hardier instrument, less maintenance: lower instrument and operational cost
  - Designed as a networkable instrument from the ground up, easily deployable in 1s, 10s, 100s
- Currently TRL 4: Breadboard validation in lab environment
  - Use existing SHS from UW Physics operating in UV-VIS
  - Currently tuning imaging system and data processing pipeline
  - Plan to make atmospheric NO_2 measurements with the breadboard in spring 2023
  - Next phase is to build SHS operating in thermal IR, 1-3 years to develop
- Benefit to ARM / ASR
  - Thermodynamic profiler, smaller physical size compared to AERI, lower fixed cost
  - Substantially easier maintenance compared to AERI, lower operating costs
  - Designed for deployment in large terrestrial networks, improved observations over large geographic regions
  - Technology can also be adapted to trace gas observations

Spatial Heterodyne Spectrometry (SHS)





Instrument development:

Harlander et al. 1992, 2003; Lawler et al. 2008; Gardner et al. 2017, Englert et al. 2004

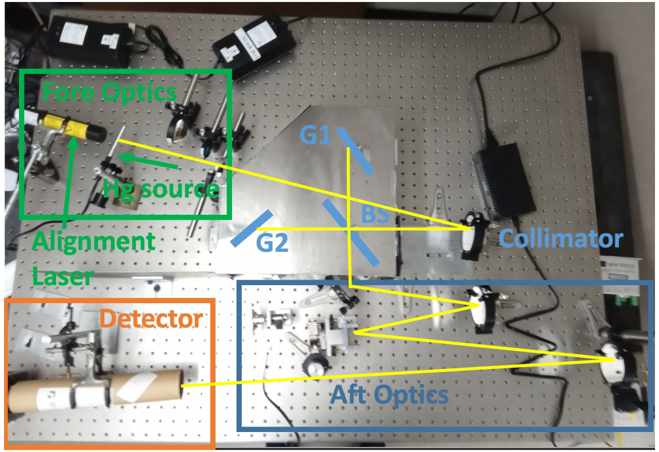
Applications:

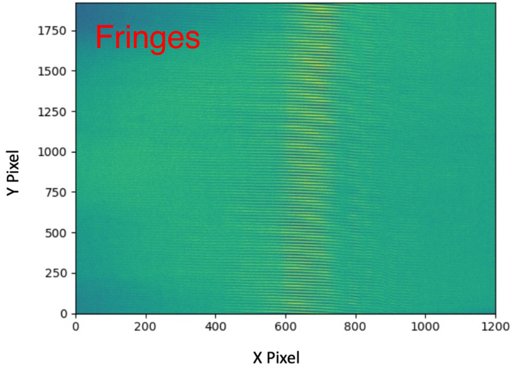
Watchorn et al. 2010; Mierkiewicz et al. 2006; Corliss et al. 2015; Englert et al. 2008, 2009, 2010; Harlander et al. 2017; Gardner et al. 2017; Langille et al. 2019

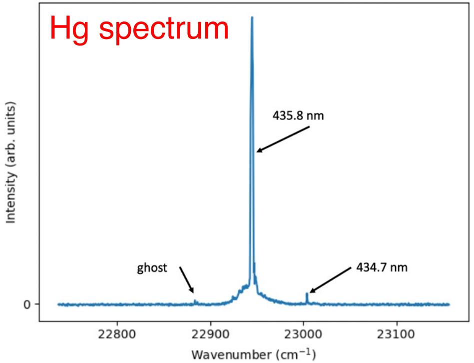
AERI vs. SHS Comparison

	AERI	SHS
Bandpass	Broad	Optimized for retrieval
Optical throughput	Nominal	Field-widened
SNR	Nominal	Higher
Instrument size	Nominal	Smaller
Design complexity	Precision FTS	No precision moving parts
Detector	Cooled single pixel	Uncooled array
Consumables	Stirling cooler, metrology laser	None
Maintenance	Highly skilled labor	Minimal
Large network operation	Not easily scalable	Scalable

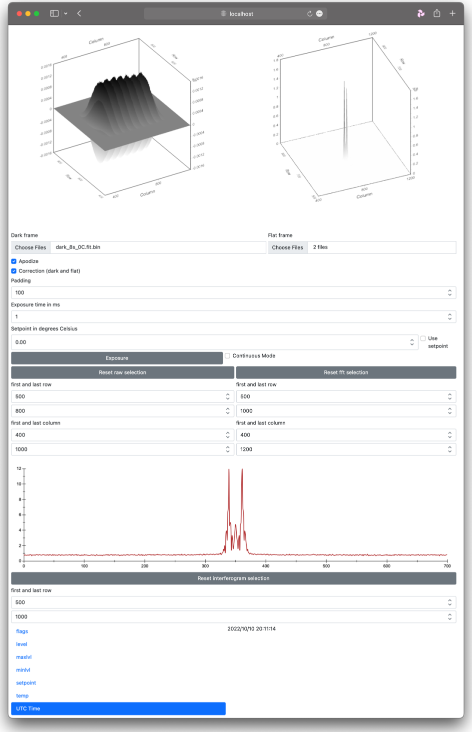
SHS Breadboard







Processing software



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SHS Breadboard Specifications

General

Magnification	1.94	
Max wavenumber	25000	cm^{-1}
Min wavenumber	22222	cm^{-1}
Resolving power	63500	
Used grating horizontal size	3.56	mm
Used grating vertical size	5.67	mm
Theoretical limit of resolution	0.35	cm^-1
FOV diameter (no field widening)	66.8	mrad
Aperture size	380	mm^2
Etendue	5.32	mm^2 sr

Imaging System

Magnification	2	
M1 radius of curvature	1	m
M2 radius of curvature	-0.33	m
M3 radius of curvature	0.5	m

Grating

Blaze angle	63	degrees
Pitch	0.00431	cm
Full horizontal size	4.6	cm
Full vertical size	9.6	cm
FSR	130.2	cm^{-1}
Single grating tilt	13.7	mrad

Detector

Pitch	5.86	um
Horizontal pixels	1920	
Vertical pixels	1200	
Quantum Efficiency	60	%
Read noise (@ gain=16)	3	e rms
Dark current (@ 0 C)	0.62	e/s
Full well capacity	32000	e