Progress Report: EXES, the Echelon-Cross-Echelle Spectrograph for SOFIA

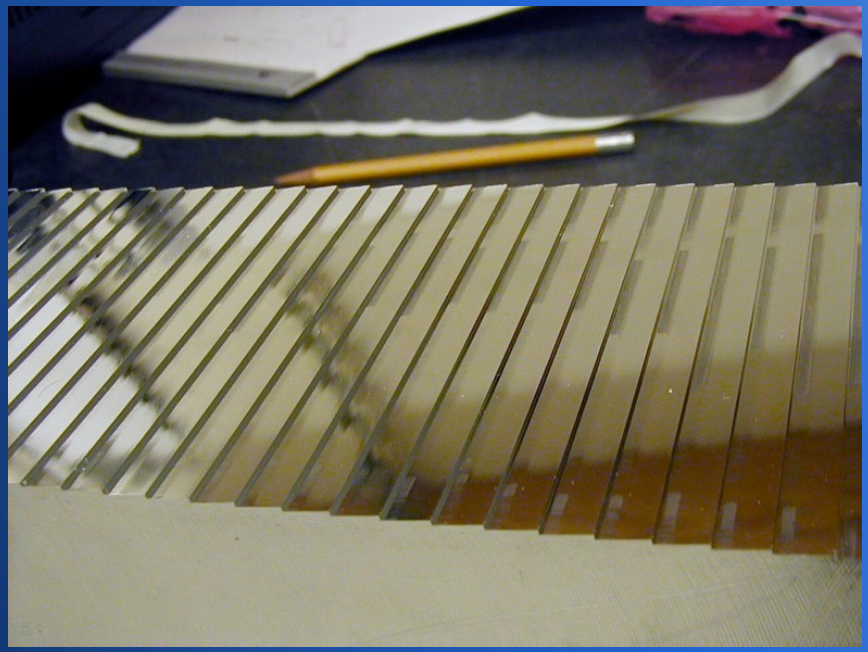
EXES Team:

- Dr. Matthew Richter, PI, UC Davis
- Mark McKelvey, Co-I, NASA Ames
- Dr. Curtis N. DeWitt, UC Davis

EXES is a PI-Class First-Gen SOFIA SI, presently scheduled to complete commissioning in November 2014

EXES Overview

- Mid-infrared spectrograph for wavelengths from 4.5 – 28.3 μm, CO band to H2 J2-0.
- 1 Mp Si:As IBC detector array
- Configurable over a range of resolution (~10^3 to >10^5).
- Primary science: molecular ro-vibrational transitions for chemistry in high-mass star forming regions, atmospheric mapping of solar system objects.



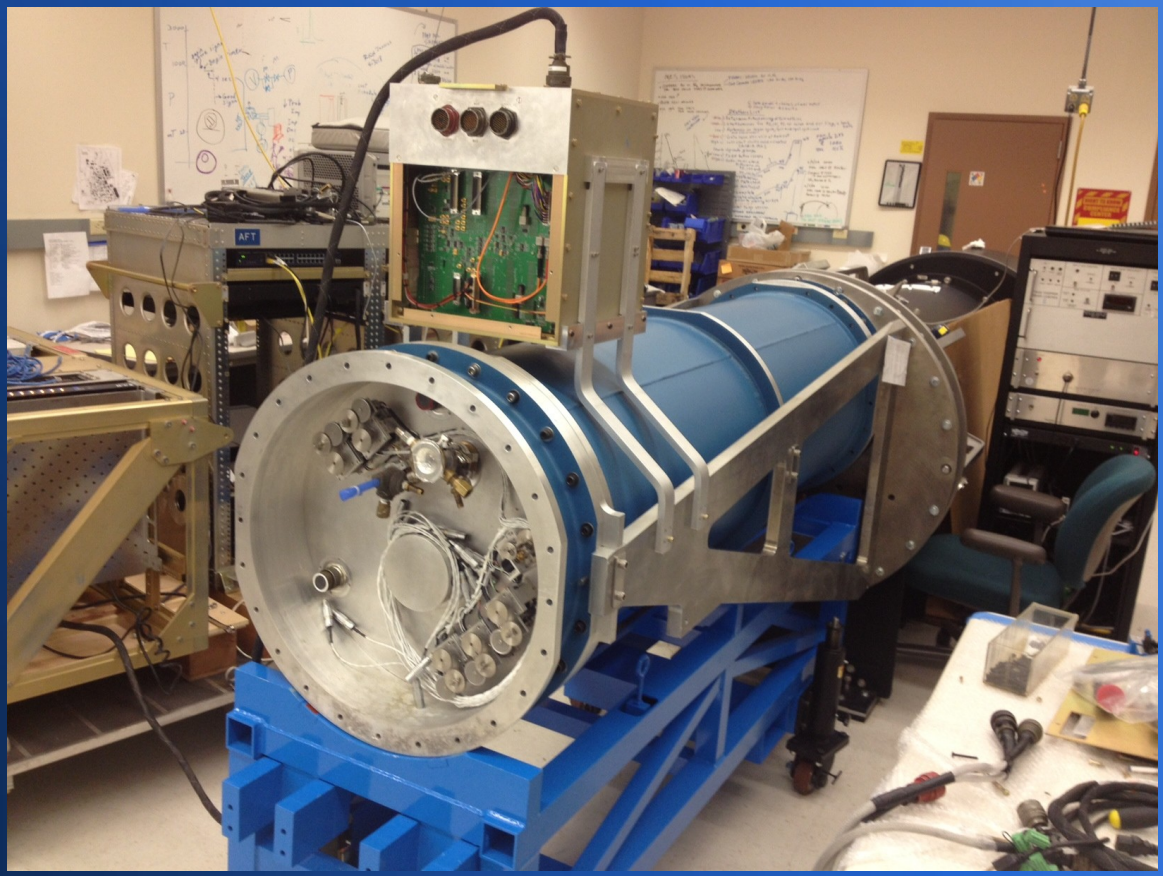
EXES Echelon: 1m length, .131 grooves/mm

A Brief History of EXES

- 1998 selection as a 1st-Gen SOFIA SI (Lacy).
- Moved to NASA Ames for continued development in 2009 (Richter).
- IRTF observations in January 2011.
- Present laboratory efforts focused on optimizing instrument performance, AW certification, and software development.
- Sister instrument TEXES in use @ IRTF + Gemini

Status

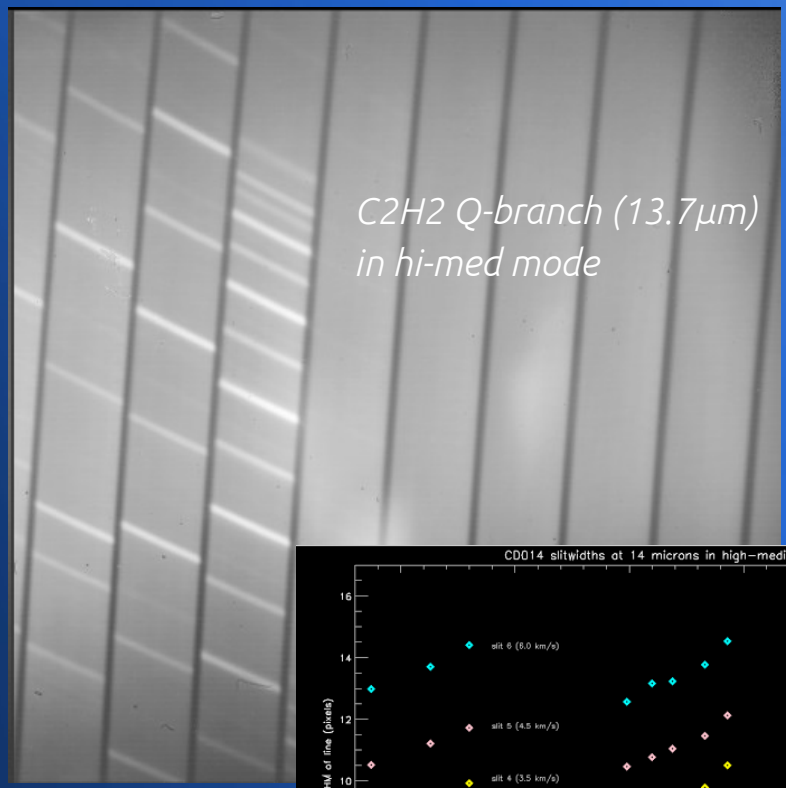
- Recent cold tests
- TAAS integration
- Detector optimization
- Calibration unit
- Software development
- Programmatics
- Schedule
- Cycle 2

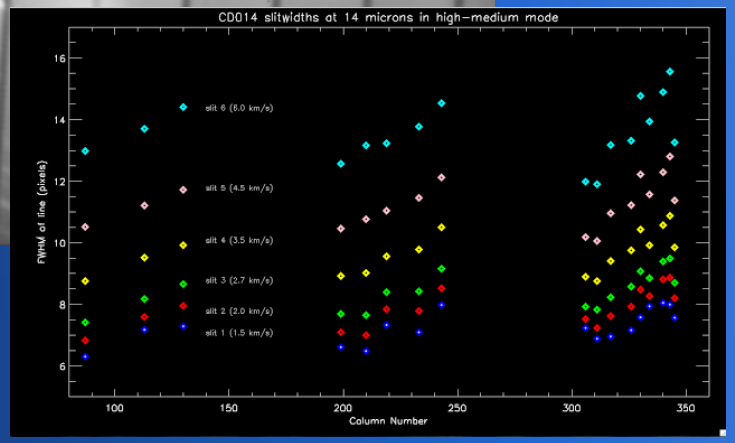


EXES installed on TAAS2

Recent Cold Tests

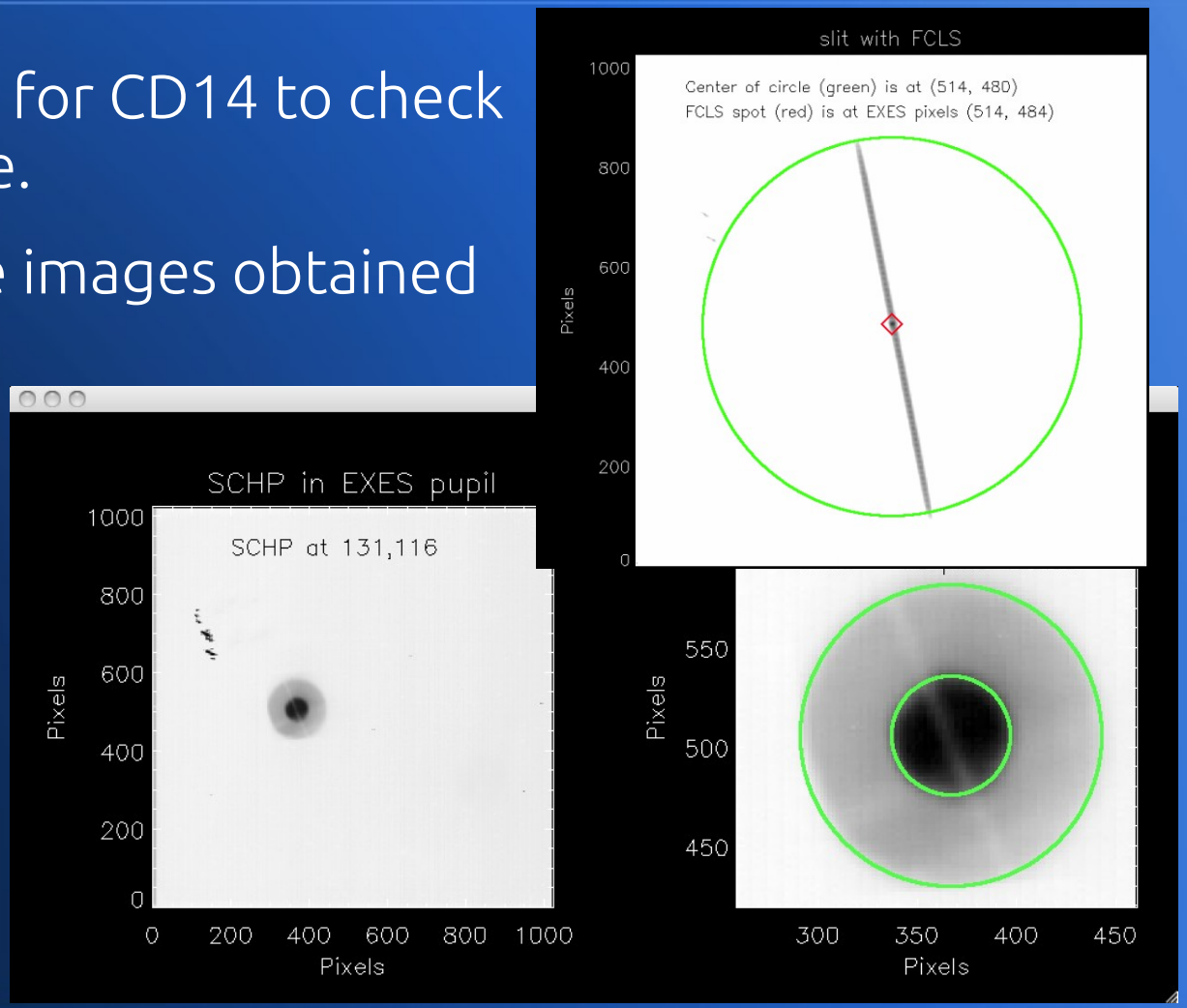
- Cooldown 14 conducted Jan-Mar to optimize optics and characterize performance (backup detector array).
- Demonstrated R=109k (112k design) for our 1.44” slit, the narrowest we expect to be able to use on SOFIA.
- Pinhole features close to diffraction limited, so spatial resolution would be good. Still room to improve.





TAAS Integration/Testing

- EXES installed on TAAS2 for CD14 to check alignment, camera mode.
- Camera- and pupil-mode images obtained of SCHP and FCLS.
- Size of SCHP consistent with desired 95% size coldstop/secondary.
- Short – λ (4.5 μm) FCLS continuum spectra collected in medium-res mode.

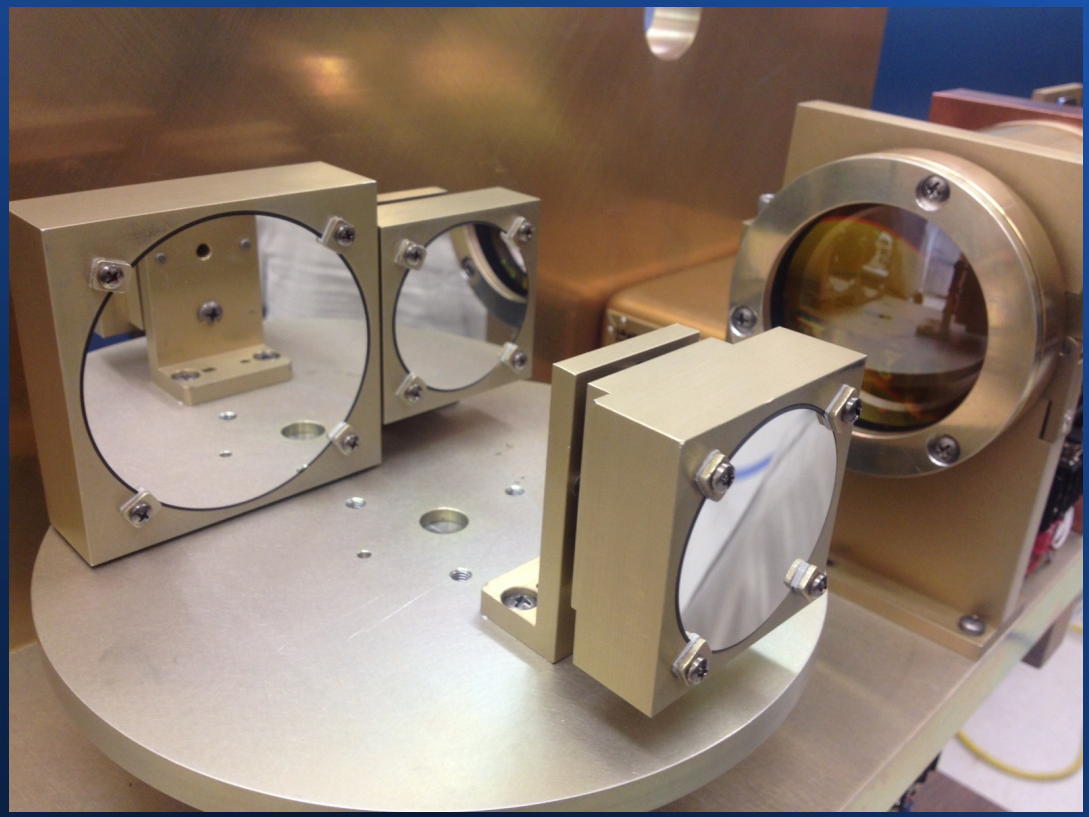


EXES 4.5 μm image of TAAS SCHP (pupil) + FCLS (camera)

Detector Optimization

- Experimenting with location of single-point ground...chasing pickup noise from motor controller boxes.
- Now able to drive array @ ~8Hz full-frame, faster than array can handle. 4Hz rate looks good (optimizing).
- Short-scan in lo-med mode allows higher backgrounds (of order 10M ph/pix-s).
- MIRI-like noise previously demonstrated.
- Performance good, but plenty of niggling issues to work!

Calibration Unit

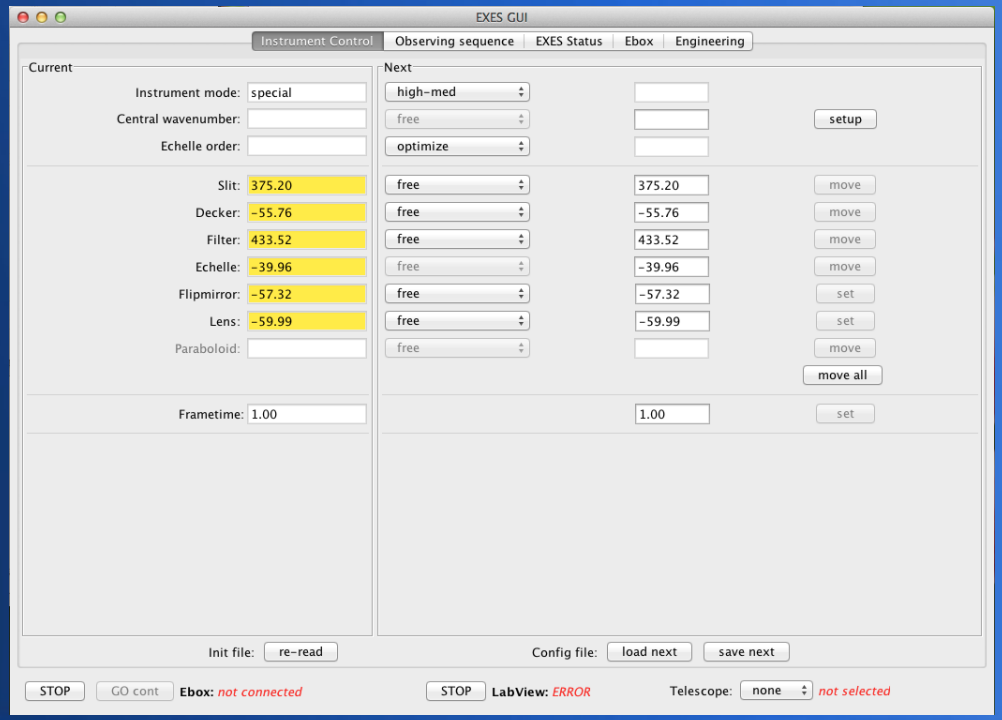


EXES cal unit closeup, showing turntable and BB source (right). Unit mounts to aft side of 41" mounting flange, inside INF 'tub'.

- Tub-mounted module used for the first time during CD14.
- Motorized turntable allows view of sky, temp-controlled blackbody source, or retro-reflector, <1s transitions.
- Allows periodic flatfields.
- Provision for gas cell to provide laboratory spectral calbibrations.

Software Development

- New eBox firmware provides more flexibility in detector operation (thanks to FORCAST team!)
- UI maturing, now provides menu-select of wheel features, modes, and x-disperser angle.
- Draft plans for Tier 1 & 2 tests. Hope to complete tests over next few weeks.
- 'Quicklook' and pipeline software have work ahead.



EXES Top-Level GUI Window

Programmatics

- Collaborative agreement between NASA and UC Davis extended through Q2 FY15 to accommodate aircraft schedule changes.
- Airworthiness documentation submitted, under review by SIAT @ DAOF.
- ICD V & V matrix, plus procedure development underway.

Schedule

- Working toward pre-ship review NLT Jan 2014. Need AW review feedback.
- Current 'lego' has EXES scheduled for:
  - First install/line ops Mar 10-14, 2014
  - First commissioning flights Mar 18/20, 2014
  - 4 commissioning flights scheduled for Nov 2014
- EXES Team has requested line ops 6+ weeks before first flights as risk reduction.
- EXES to be offered shared-risk in Cycle 2.

Cycle 2

- Working with USRA team regarding information for EXES to be included in Cycle 2 call:
  - Offer high-med mode (top priority) and medium mode.
  - Expect to use blackbody in cal unit as flux and atmospheric calibrator for GIs in Cycle 2.
  - Key EXES parameters for GIs to specify will be instrument configuration (high-med or medium), central wavelength or wavenumber of setting (as accurately as possible, including Doppler shifts expected), observing mode (nod on slit, nod off slit, or map), estimated clock time to get desired (specified) S/N.
- EXES team will take data, reduce data, and deliver Level 1 to Level 3 (calibrated with BB) data products to DCS within a month of completion of flight.

Backup: Image Quality

- Estimated image quality for EXES as a function of wavelength: