UV spectroscopy requires a selection of spectral resolving powers combined with excellent angular resolution:

The capability of HST/STIS must be built upon for the HWO

UV spectroscopy needs intermediate steps to get there

A spectrum is worth a thousand pictures ---- Blair Savage
A spectro-image is worth a thousand spectra!

Ted Gull
GSFC Emeritus
STScI Adjunct

What HST/STIS accomplished:

UV-Visible-Near Red imaging spectroscopy

Resolving powers: 100, 1000, 10,000, 100,000

with diffraction-limited angular resolution

Stable UV sensitivity for 24 years

What HST/STIS did not accomplish:

FUV spectral response below 1175A

Spectropolarimetry

Ability to record the brightest sources

Eta Carinae and the Homunculus

Overlying question:
What led to the Great Eruption and how did a binary survive?

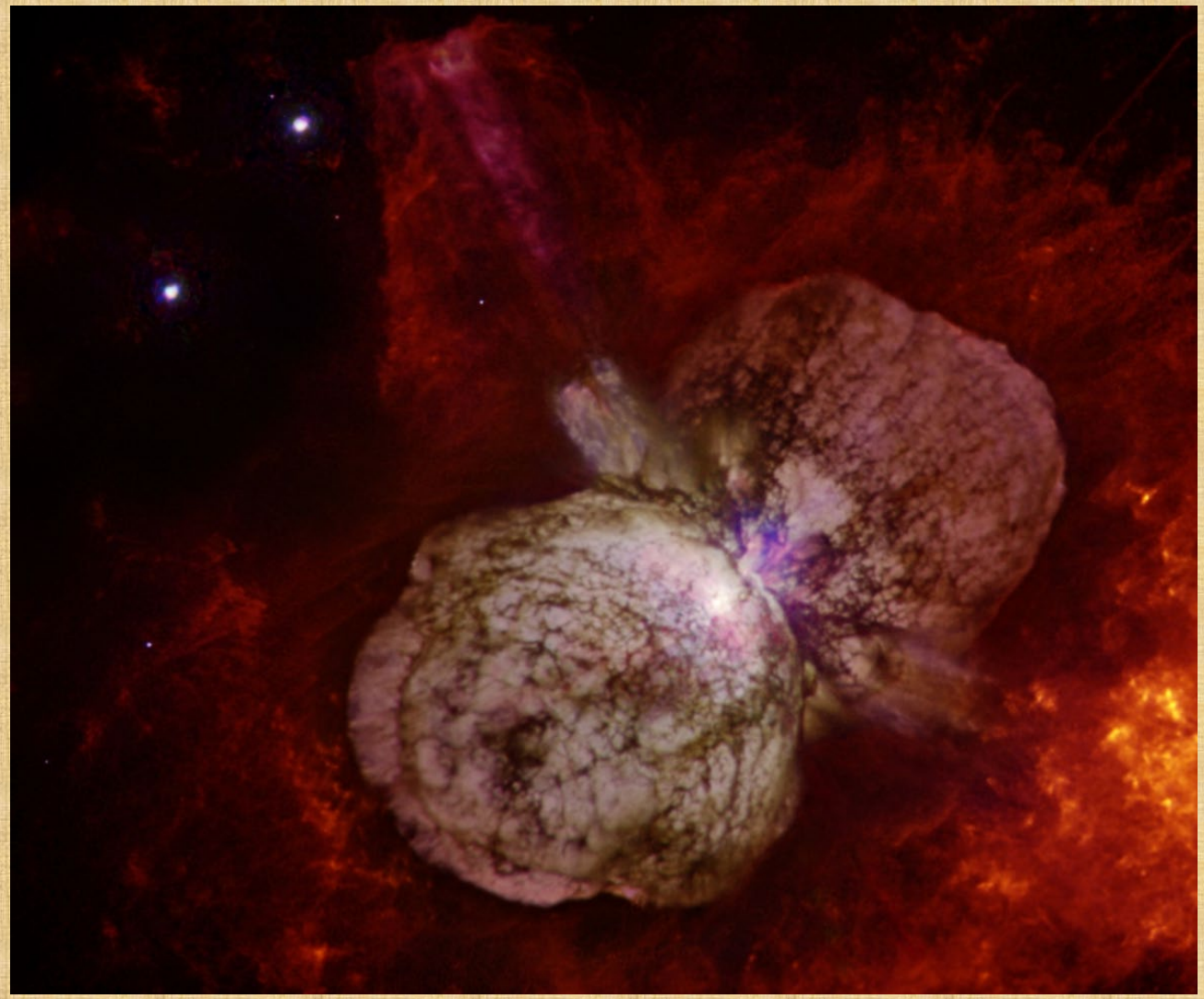
~ 40 M_o ejected!

N >> C, O (>60 M_o)

primary ~100 M_o

secondary ~60 M_o

Bulk of ejecta in disk region of orbital plane on far side of Eta Car.

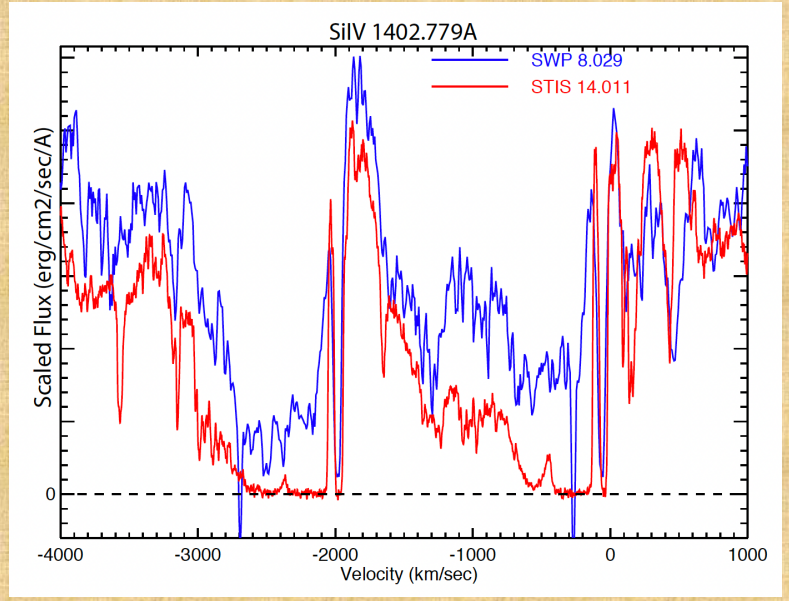


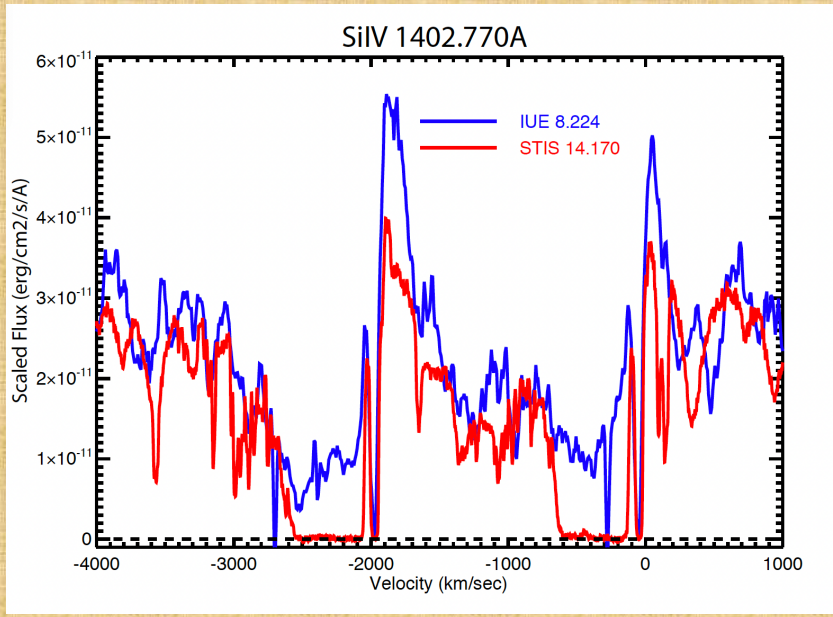
IUE 10”x20” compared to STIS 0.07”

Until 2010, nebular scattered light exceeded flux from Eta Carinae.

Major differences due to absorption differences in in multiple directions.

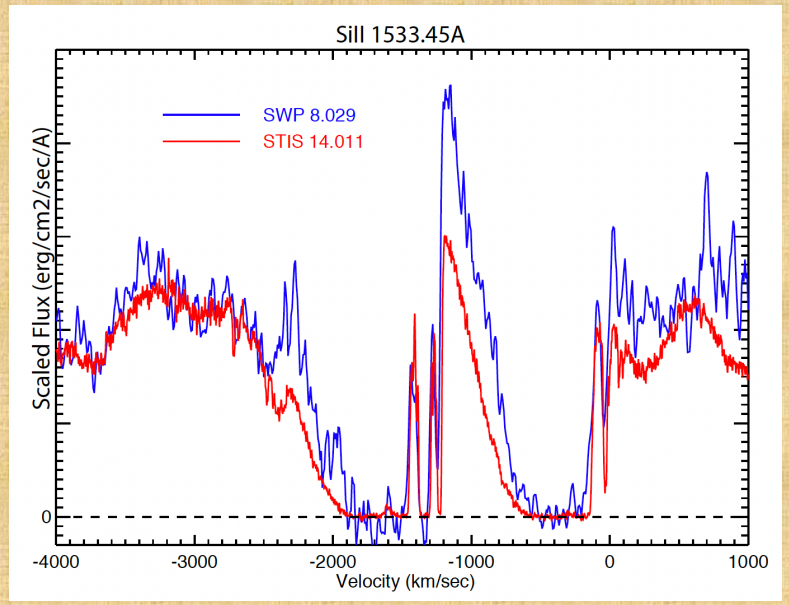
Observing from far side: UV absorption many magnitudes, so no information on dominant wind lines.

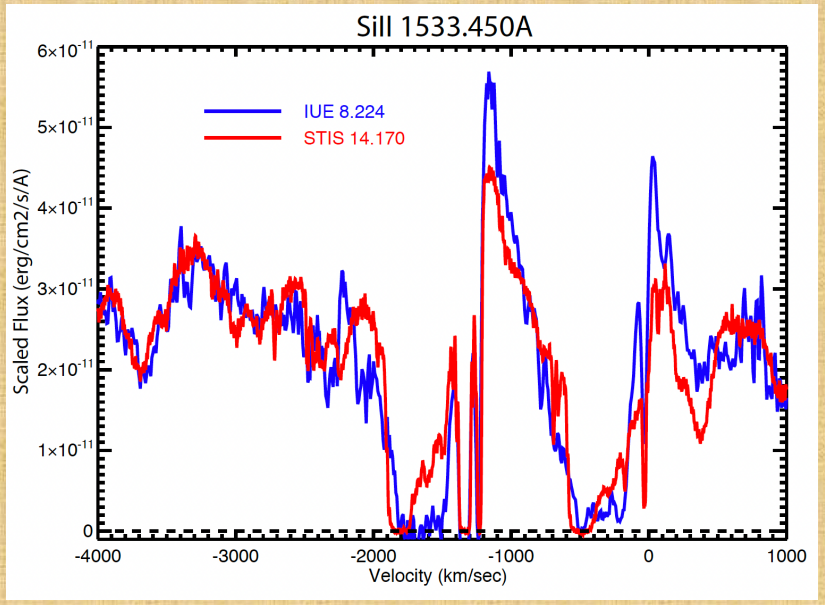




Low State

High State



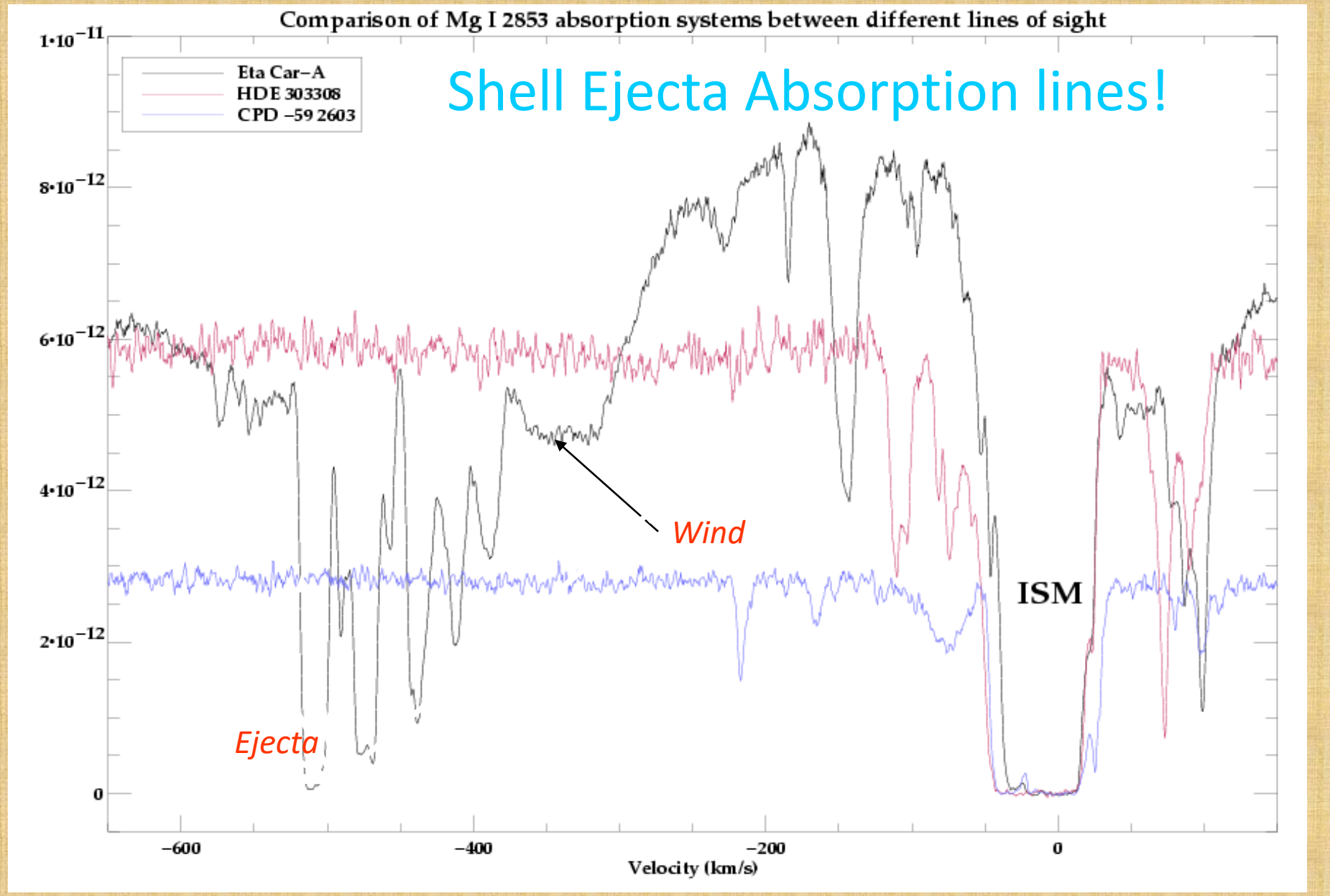


Line of sight Mg I toward Carinae stars

STIS finally resolved Eta Carinae from the nebula! BUT:

Welcome to my nightmare!!
-- John Hillier

The spectrum of Eta Carinae is complex, challenging to stellar modelers, nebular observers and atomic spectroscopists!!

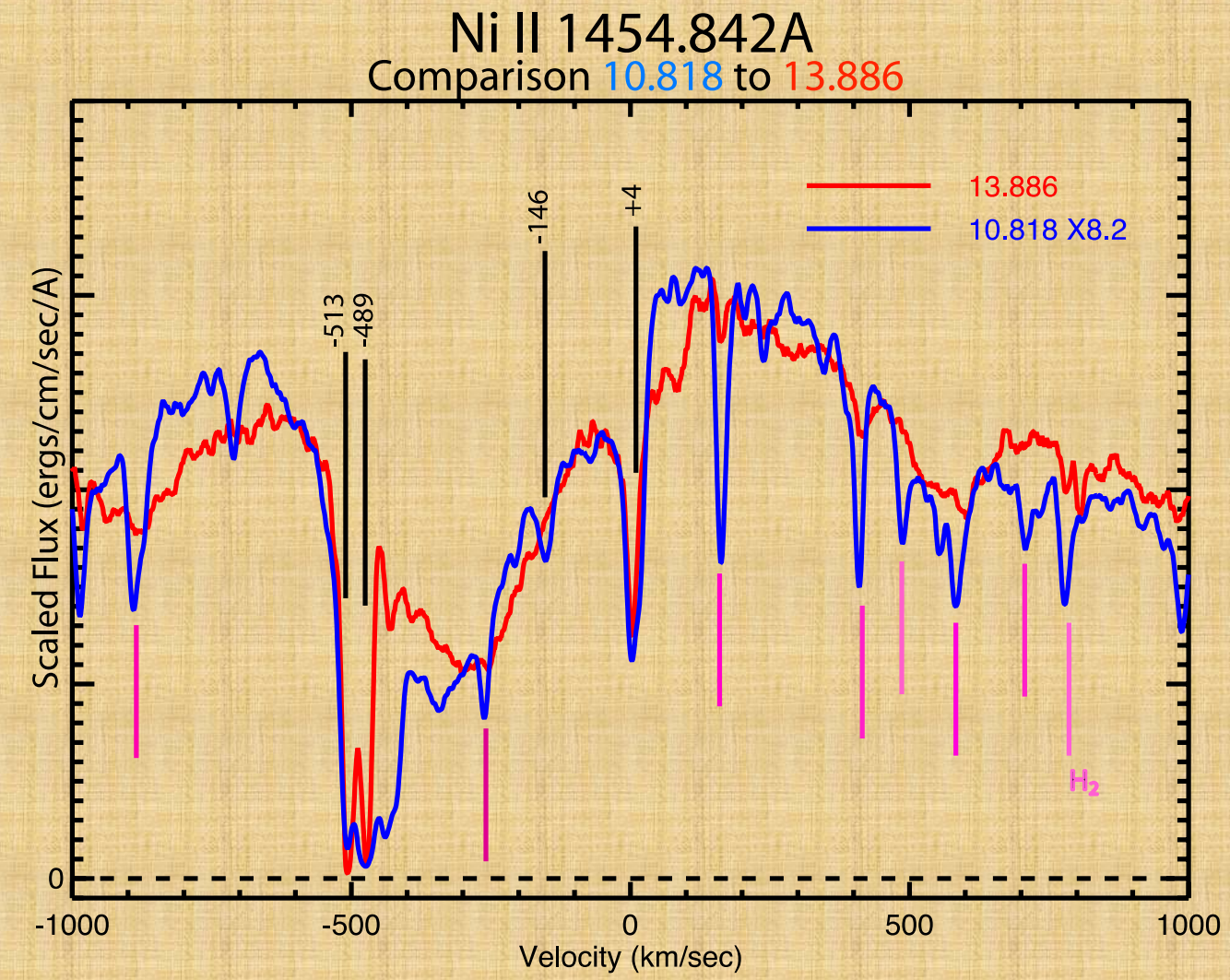


The UV spectrum of Eta Carinae has changed:
long term (changes from 2000 to 2020)
high state/low state every 5.54 year cycle

- The 1250 to 1700A flux increased 10-fold between 2000 and 2020. H_2 at -513 km/s destroyed.
- High ionization state: stellar profiles recorded in high ionization state did not change substantially.
- As periastron approached, a high-velocity transient appeared from the hot, secondary wind.
- NUV spatial structures changed between 2000 and 2020
  - Thousands of singly-ionized metal absorptions disappeared.

Example of long-term changes:

2000–2004: ~800 strong absorptions of at -513 km/s
2019: nearly all absent.
Caused by 10-fold increase of FUV which destroyed H_2

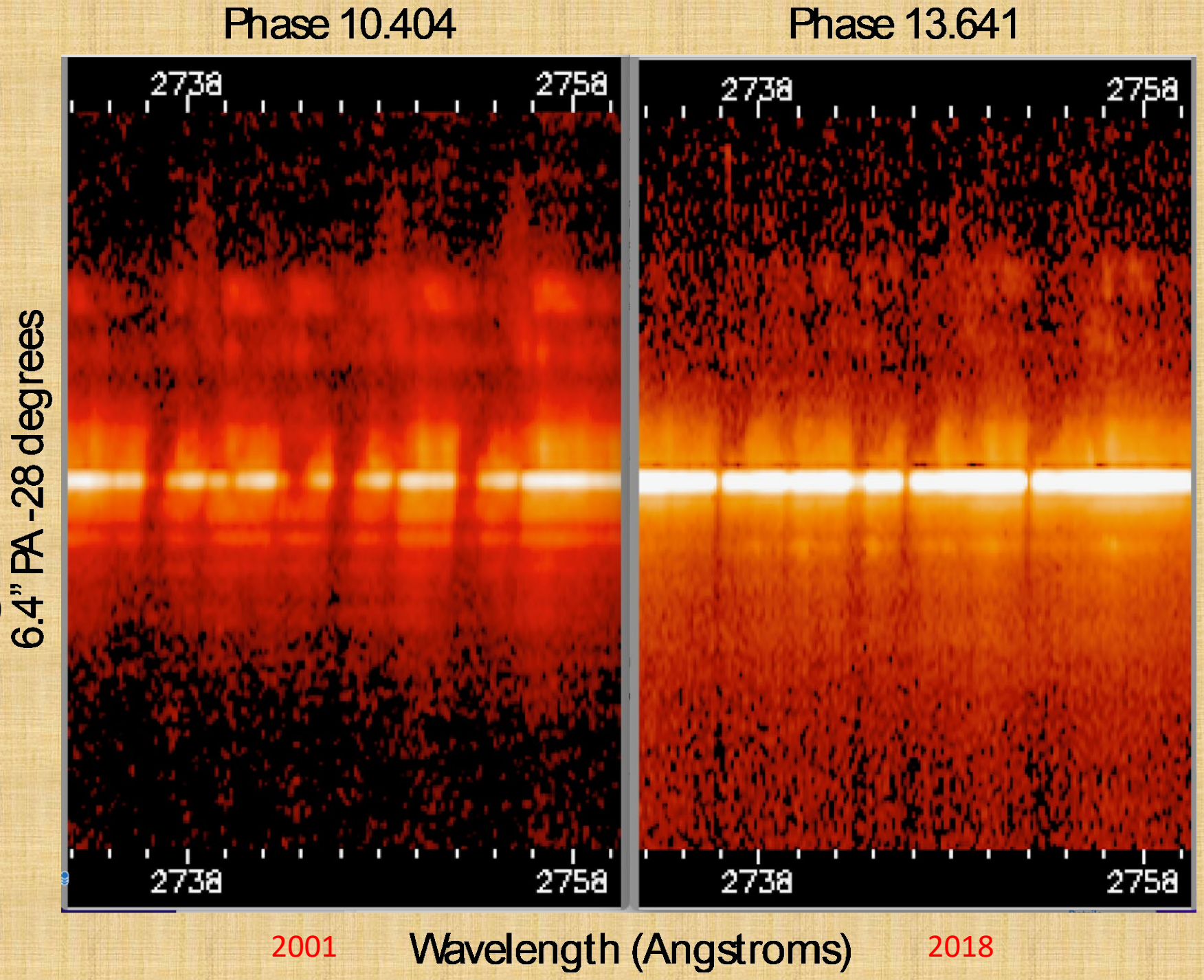


Absorption lines from Homunculus and Little Homunculus change dramatically:

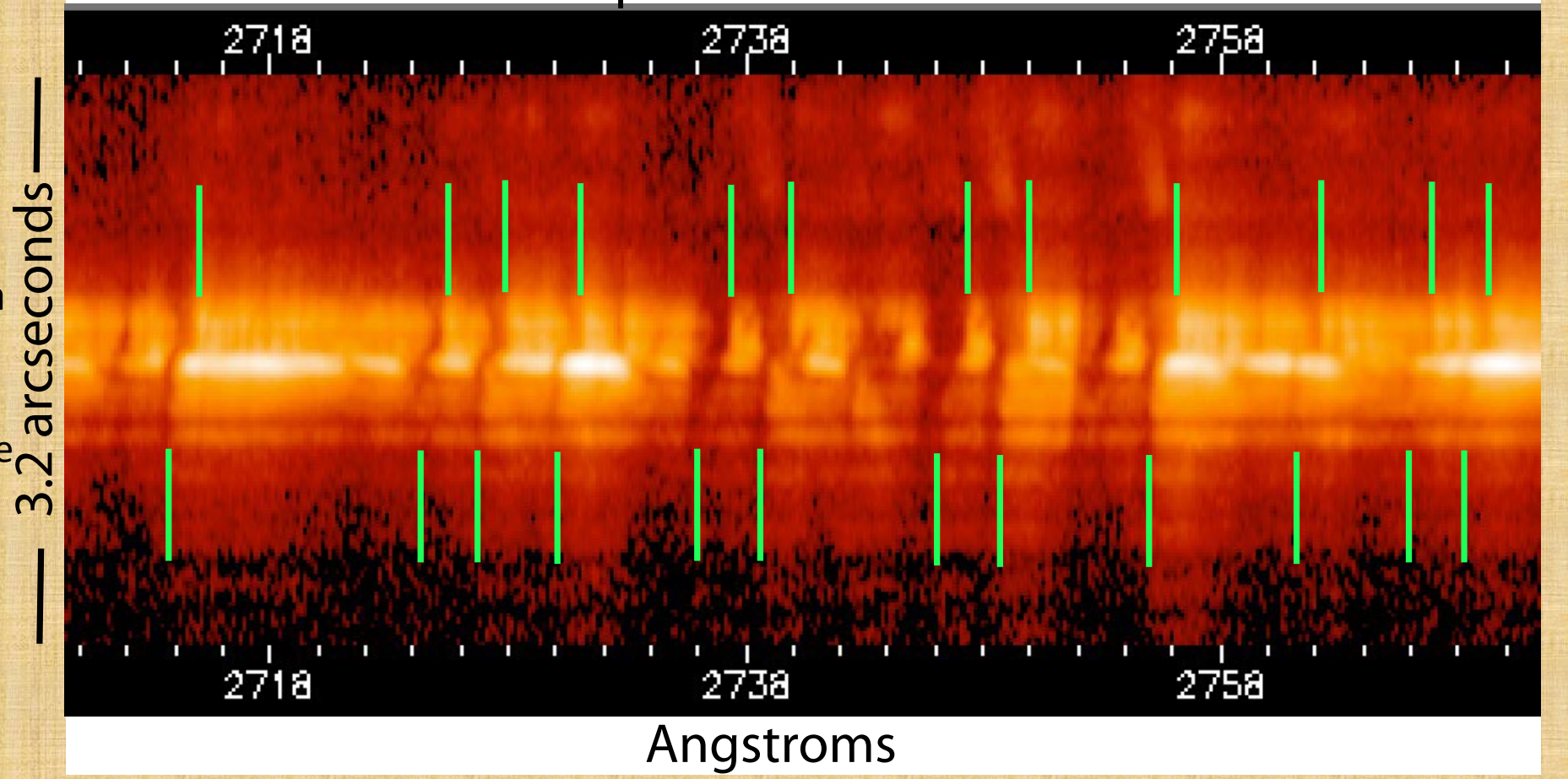
Below Eta Car, broad Absorptions narrowed.

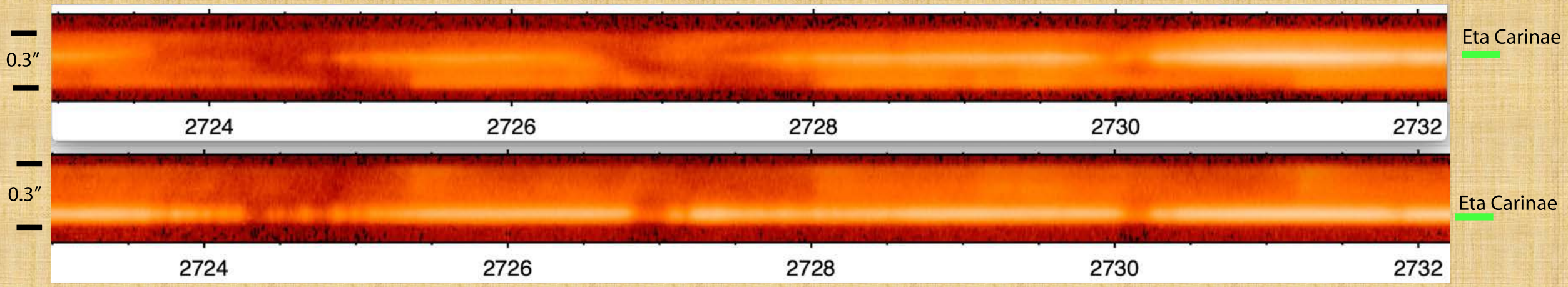
Abrupt jump in absorption across Eta Car. (Transition from shells in LOS to wind-blown cavity)

Changes in flux found due to obscuring ejecta, not changes in binary!



Absorptions from Little Homunculus shift in front of Eta Carinae:
Evidence of the occulter located close to Eta Carinae Hundreds of absorption lines with multiple velocity components in LOS.





Looking to the future:

Ultimate goal is imaging spectroscopy with HWO

Applications:

- Galaxies and regions of star formation
- Massive binary stars and their winds/ ejecta
- Exoplanets
- Solar system

Improved technology: ***must be tested with intermediate missions!***

- UV detectors with high DQE,
- low background,
- large format,
- stable performance over lifetime of observatory,
- high dynamic range from bright stars to faint nebulosities.

Concern: Diffraction effects of multi-mirror vs. single mirror…