

300 Seconds Above 160 Kilometers

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Abstract



Slitless spectrographs offer a way to measure doppler shifts across a wide field of view in a single snapshot. MOSES, a rocket borne instrument forming simultaneous images of He II Ly alpha (30.4 nm, $T \approx 50,000$ K) at several spectral orders, observed explosive events in the solar atmosphere on February 8, 2006. A second launch on August 27, 2015 observed doppler shifts in a solar active region in Ne VII (46.5 nm, $T \approx 500,000$ K). We are now preparing for a third flight and adding an instrument of improved design, ESIS. I will summarize what we have learned and what we expect to accomplish with ESIS.

Outline



1. Motivation
2. MOSES-I
3. MOSES-II
4. ESIS



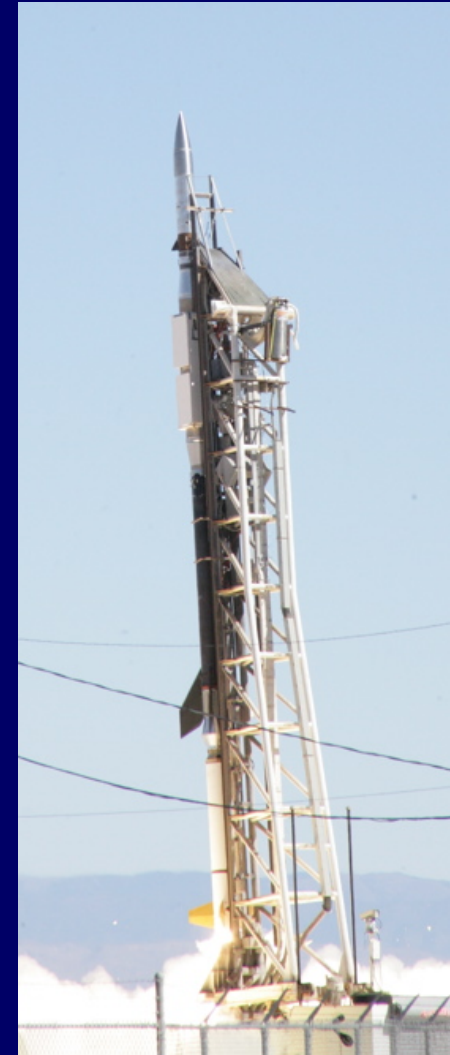
Extreme Ultraviolet Sun

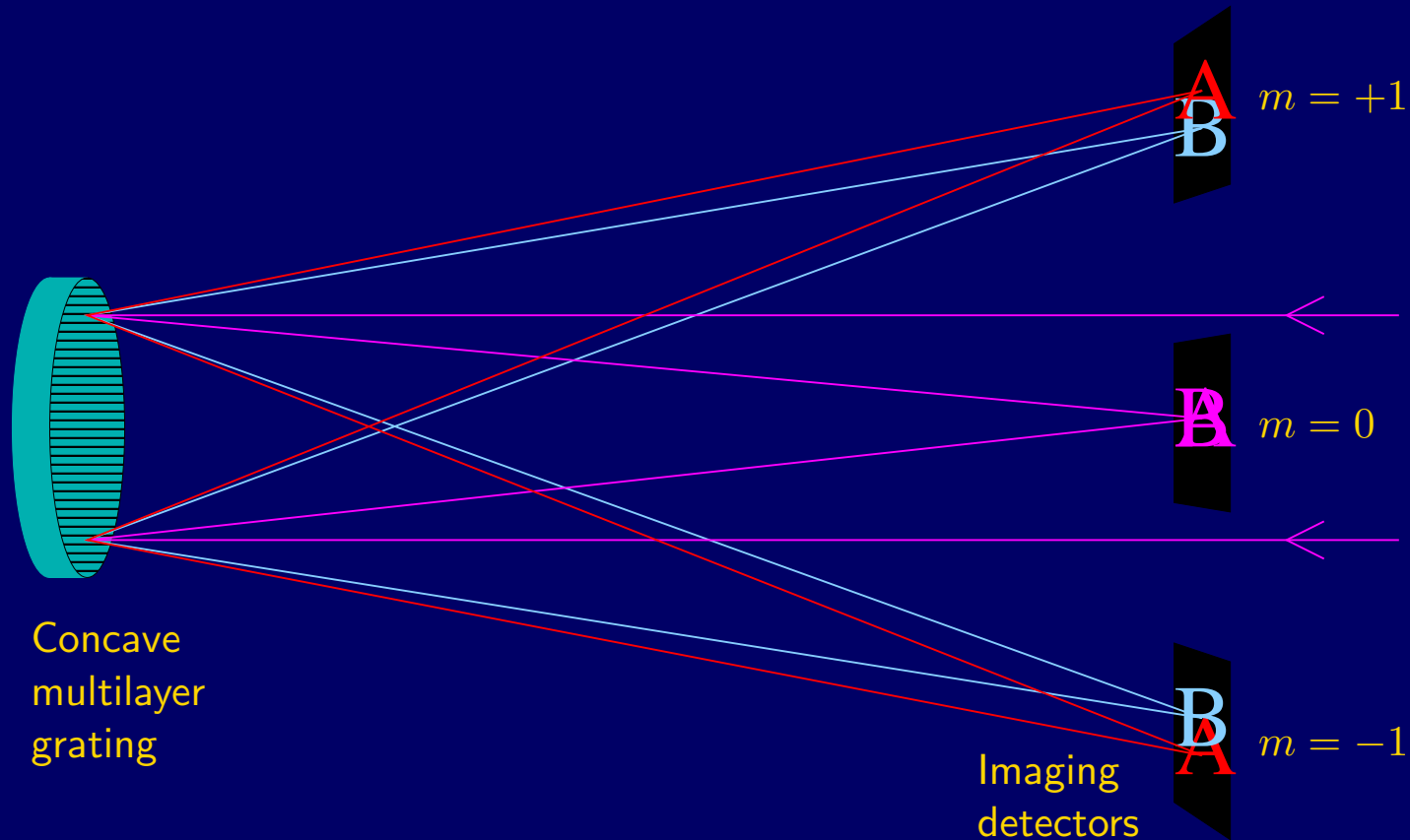


Observing From Space

- Atmosphere is opaque to EUV
 - In air (1 atm), EUV propagates about 0.01 mm
 - 50% transmission at 160 km altitude
- NASA Sounding Rocket Program
 - Suborbital
 - Inexpensive (1 % of a satellite)
 - Risk tolerance

Right: MOSES-I launch,
2006-Feb-08





Slitless spectrograph, He II $\lambda 304 \text{ \AA}$. Differences between images encode the line profile.



MOSES-I Images





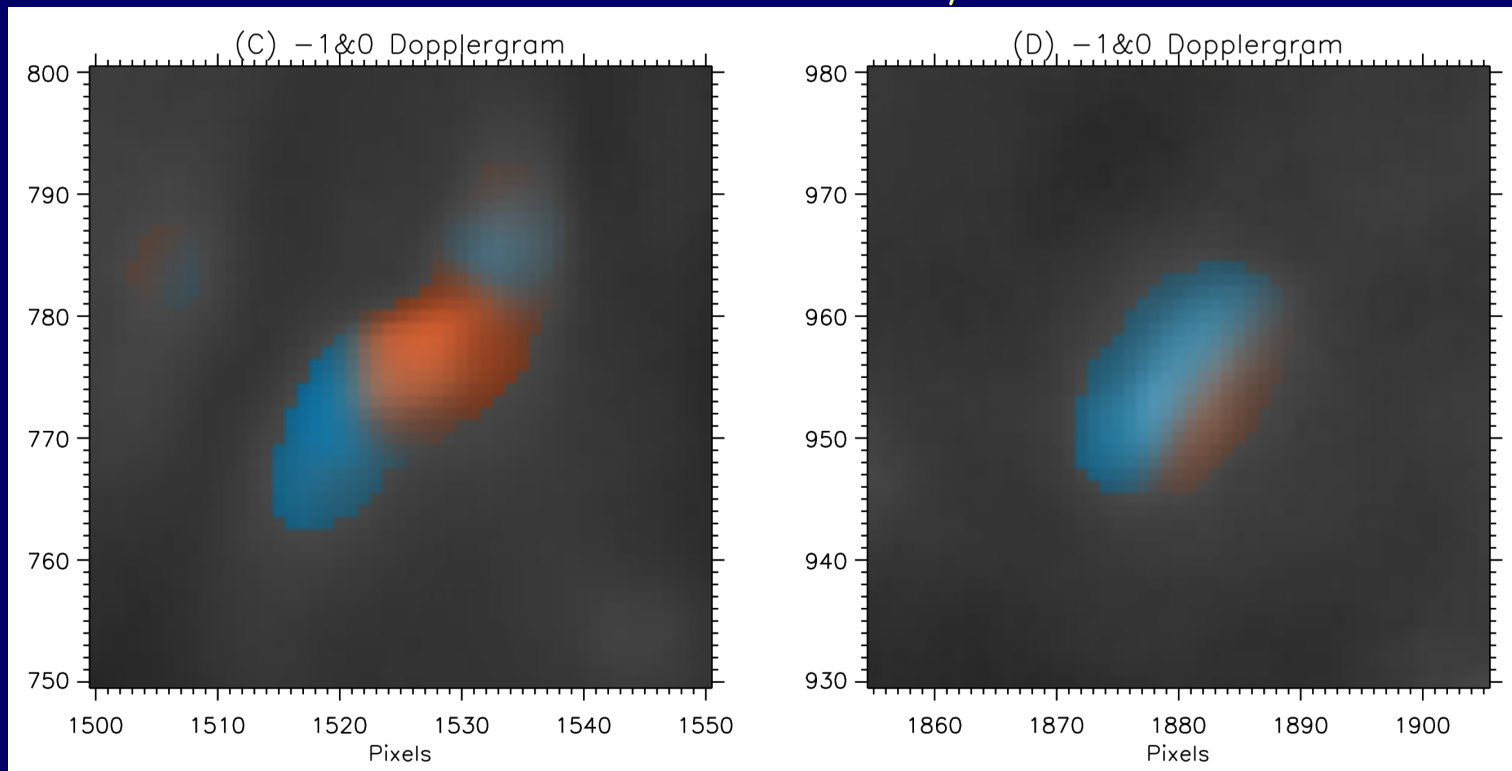
Explosive Event Observation



Fox, Kankelborg and Thomas (2010) *Astrophys. J.* 719:1132

MOSES-I Dopplergrams

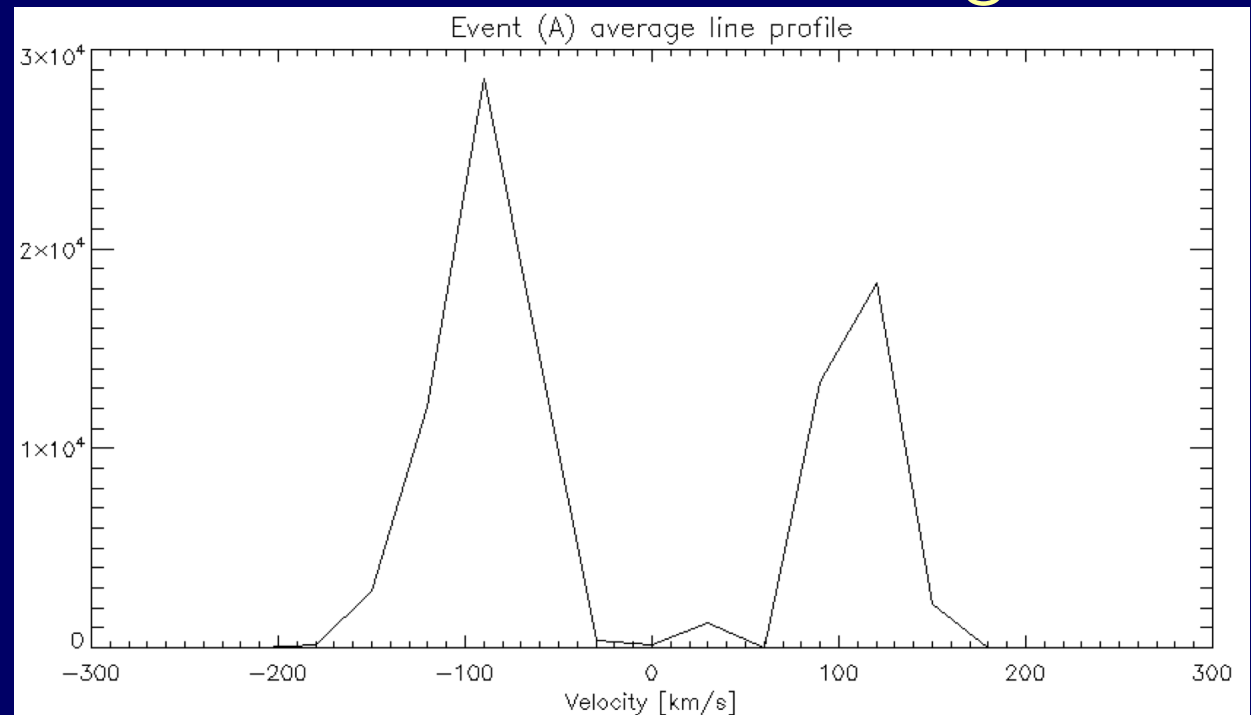
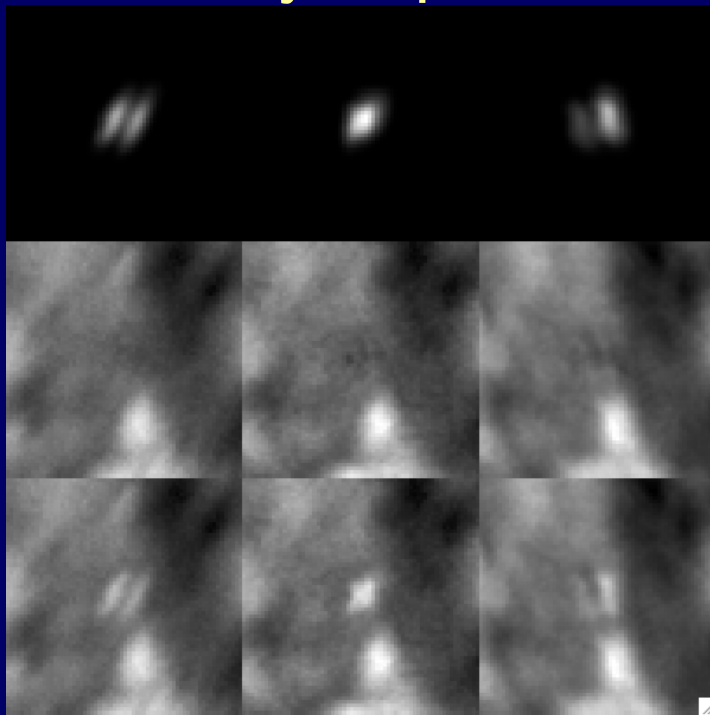
Bright red and blue correspond to line of sight velocities
around 50 km/s.



Courrier and Kankelborg, 2015 *Proc. SPIE* 9643,
doi:10.1117/12.2194607

MOSES-I Inversions

Multiresolution inversion of spatial-spectral cube.
Many explosive events in the solar transition region.



Tom Rust (to be submitted to *Astrophys. J.*)

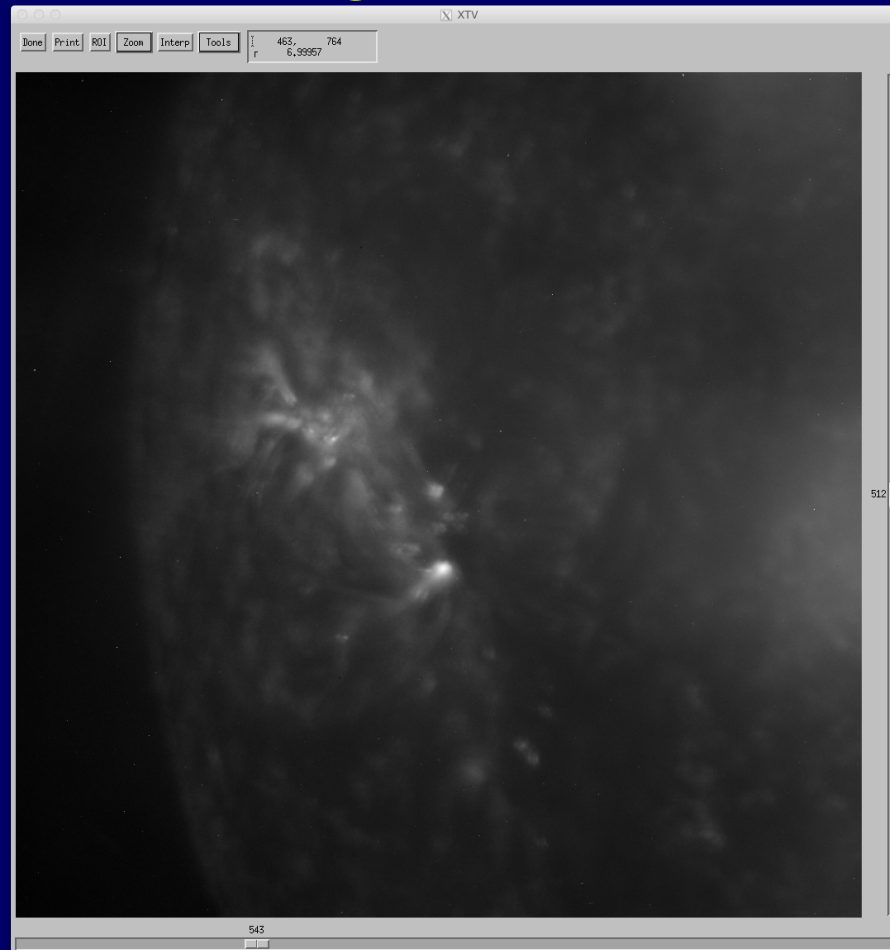
MOSES-II, 2015-Aug-27





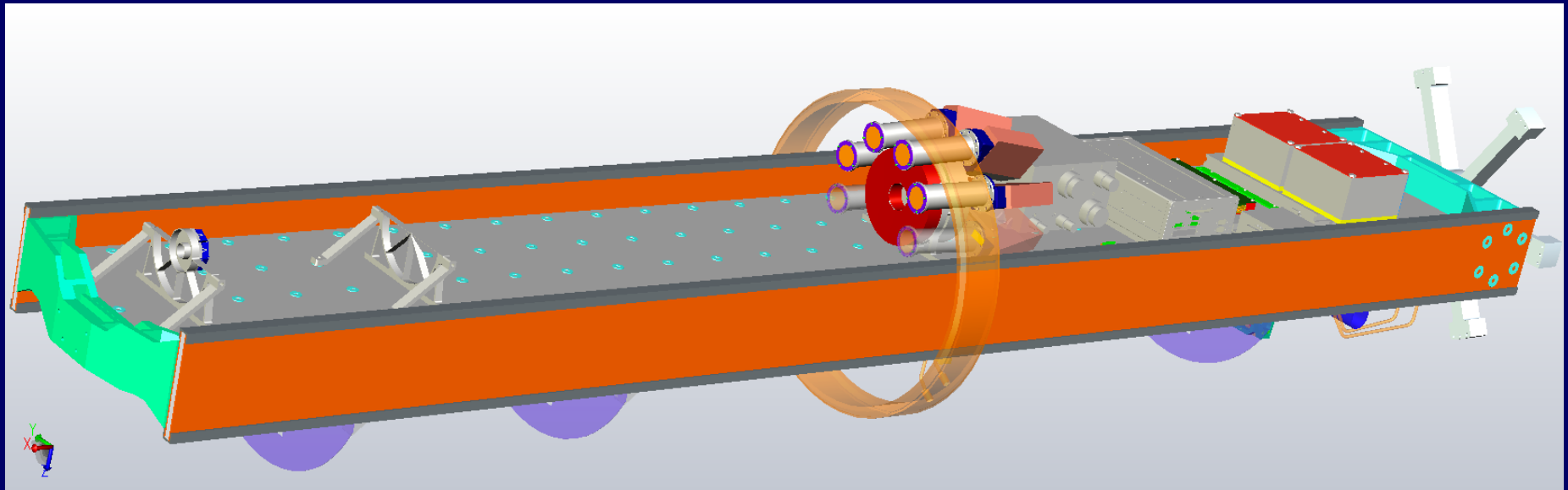


A solar active region in Ne VII, 46.5 nm.



Observations are rare in this temperature range (500,000 K).

EUV Snapshot Imaging Spectrometer (ESIS)



- New instrument design, flight in 2018
- Optics designed/build/test at MSU
- Detector system from NASA/MSFC (Jon Cirtain, Ken Kobayashi)

Afternoon Poster Session

- Roy Smart & Hans Courier — “Preliminary results of the MOSES II 2015 flight.” (SPD 2016)
- Shane Atwood — “A PSF equalization technique for the multi-order solar extreme ultraviolet spectrograph (MOSES)” (in preparation for *JEI*)

In Preparation

- Tom Rust — “Transition Region Explosive Events in He II” (*ApJ*)
- Hans Courier — “Using local correlation tracking to obtain solar spectral information from a slitless spectrograph” (*JEI*)