

An Advanced EUV Multi-Order Spectral Imager For The Solar Atmosphere

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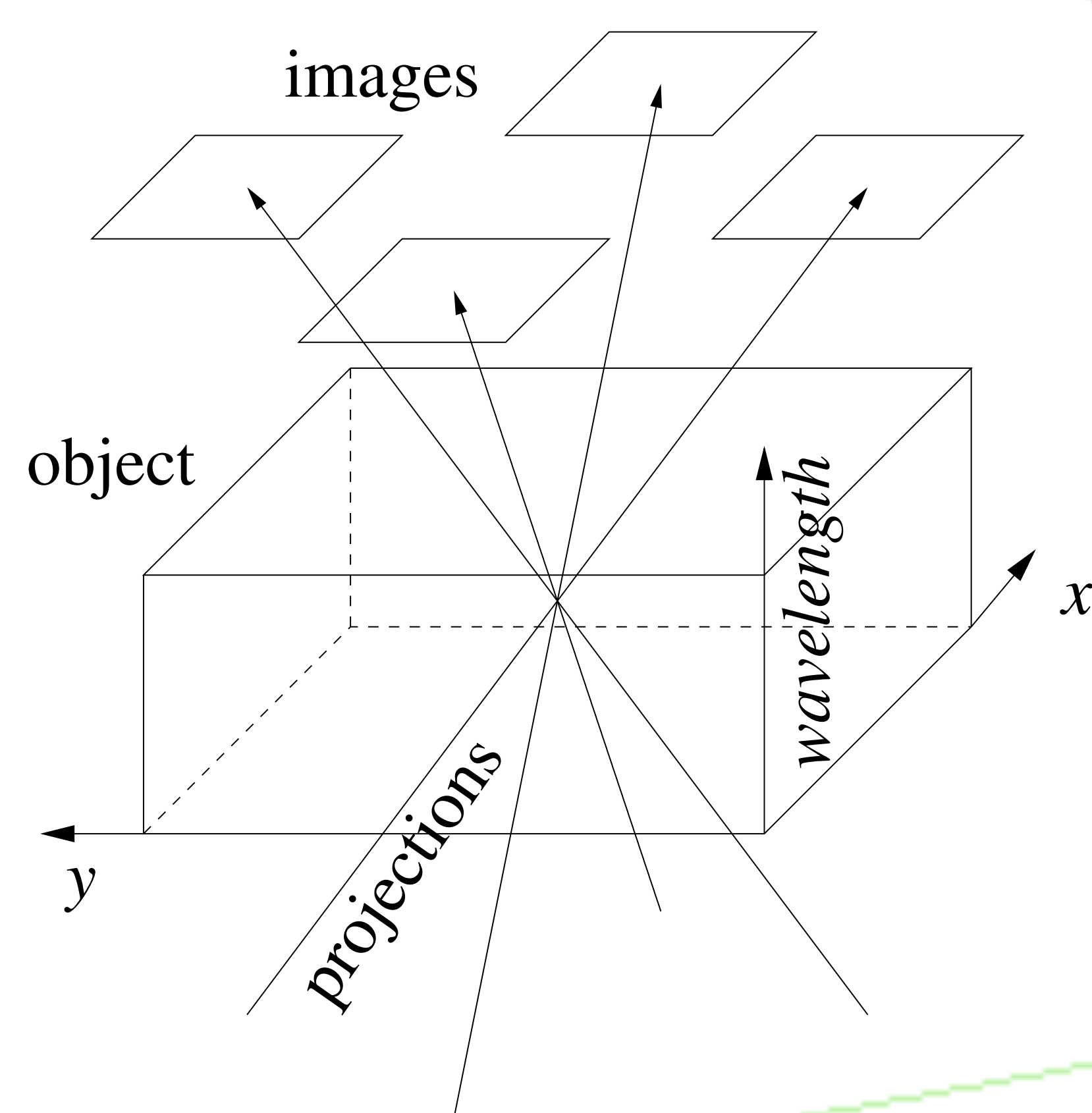
Abstract

We describe an EUV imager capable of measuring spectral line profiles at high spatial resolution over a wide field of view in a single snapshot. The instrument follows in the footsteps of the Multi-Order Solar EUV Spectrograph (MOSES) sounding rocket instrument, and could fly simultaneously within the same experiment section. The design provides higher moments of the spectral line profile and higher sensitivity than MOSES, but with a more compact optical configuration.

We call this future instrument the EUV Snapshot Imaging Spectrograph, ESIS.

Concept

The image formed by a concave diffraction grating is a projection through the object. Many such projections, with differing degrees or directions of dispersion, can be used to reconstruct the object tomographically (see illustration below). With MOSES (launched in 2006), we reconstructed the 2D distribution of doppler shifts and linewidths in an explosive event from 3 projections. ESIS is a flexible, expandable instrument concept offering 4-8+ projections, allowing the recovery of more subtle spectral signatures.



Objectives

Observation with more than 3 spectral orders makes it possible to measure line profiles with higher moments, or multiple simple emission lines. Like MOSES, ESIS will operate in a narrow spectral range. Depending on the science objectives, there are many good candidate passbands. Some wavelength selection options are listed below.

λ_0 (nm)	Ion	log T (K)	Comments
154.8	C IV	5.0	doublet
133.5	C II	4.4	Complicated line profile
121.6	H I	4.7?	Complicated line profile, geocoronal absorption
62.9	O V	5.4	
58.4	He I	4.5	Complicated line profile
52.0	Si XII	6.5	
46.5	Ne VII	5.7	MOSES II passband
33.5	Fe XVI	6.3	
30.4	He II, Si XI	4.9?, 6.2	MOSES I passband
21.1	Fe XIV, XIII	6.2	Multiple strong lines
19.5	Fe XII, XIII	6.1, 6.2	Multiple strong lines

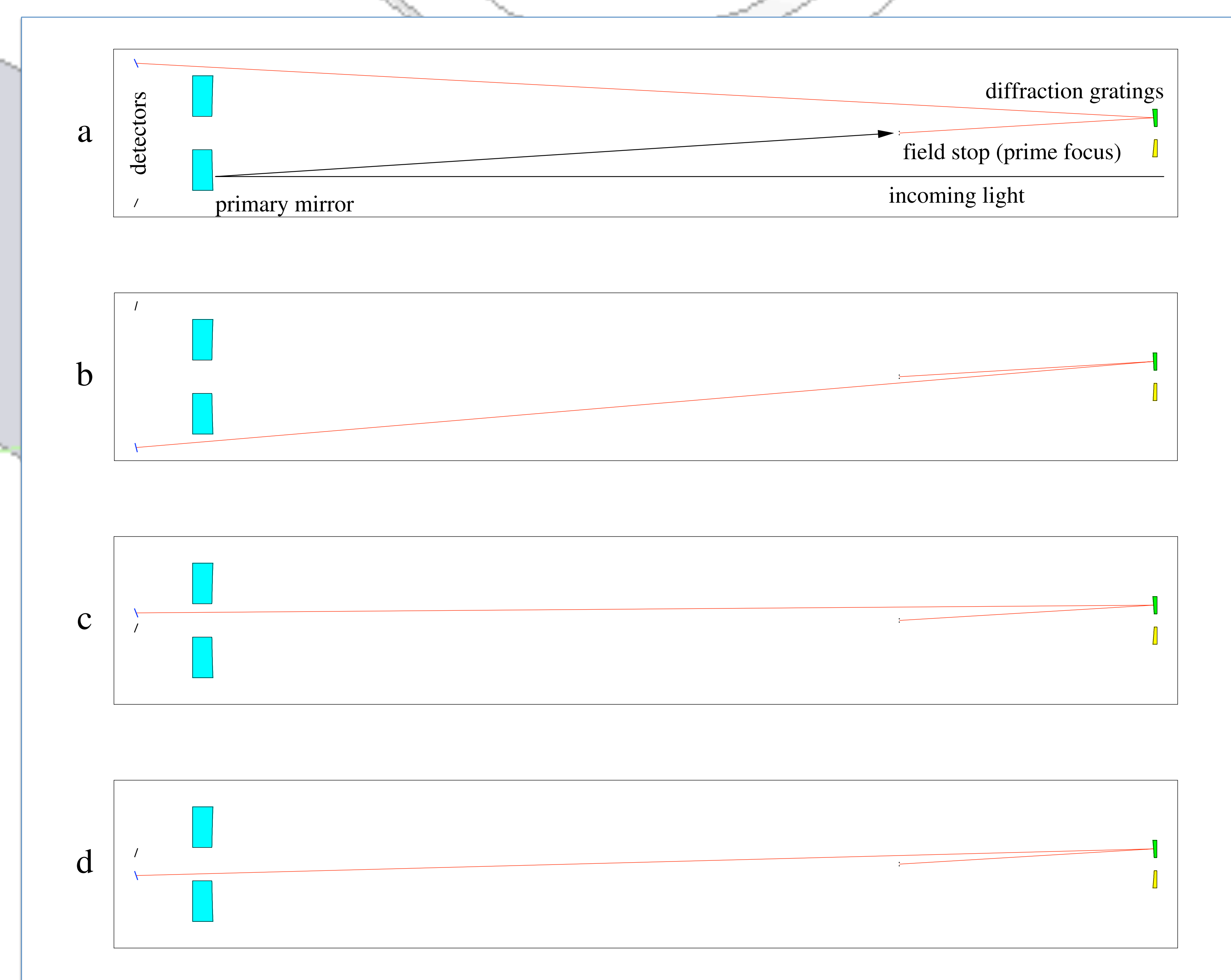
Instrument Design

Modified Gregorian	Magnification = 4.0
Primary mirror	150 mm parabola, 1.0 m focal length
Secondary "mirrors"	4+ identical, 24mm toroidal VLS gratings Holographic, ion etched. Ellipsoidal mirror provides $m=0$ image.
Coatings	Multilayer (EUV) or Al/MgF (FUV)
Detectors	1280x1024 CMOS, back-illuminated, 10.8 μ m pixels
Spatial resolution	1.1 arc seconds
Command & Data Handling	Single board computer, CameraLink via PCIe

Advantages

- 4+ spectral orders \rightarrow Many constraints on reconstruction. Sensitive to high moments of line profile.
- Dispersion out-of-plane \rightarrow Doppler shift sensitivity for filamentary features regardless of orientation.
- Magnification ($M=4$) \rightarrow Compact system .
- Field stop \rightarrow Eliminates edge effects.
- TVLS gratings \rightarrow Each image is independently aberration-corrected.
- Single, small grating design for all projections \rightarrow Manufacturable at low cost.

Four alternative layouts



Each of the four layouts entails a grating design with different dispersion, and thus different velocity resolution.

	Δv (km/s/pixel)
a	4.2
b	19.7
c	9.3
d	14.4

Acknowledgments

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