National Astronomical Observatory of Japan
国立天文台

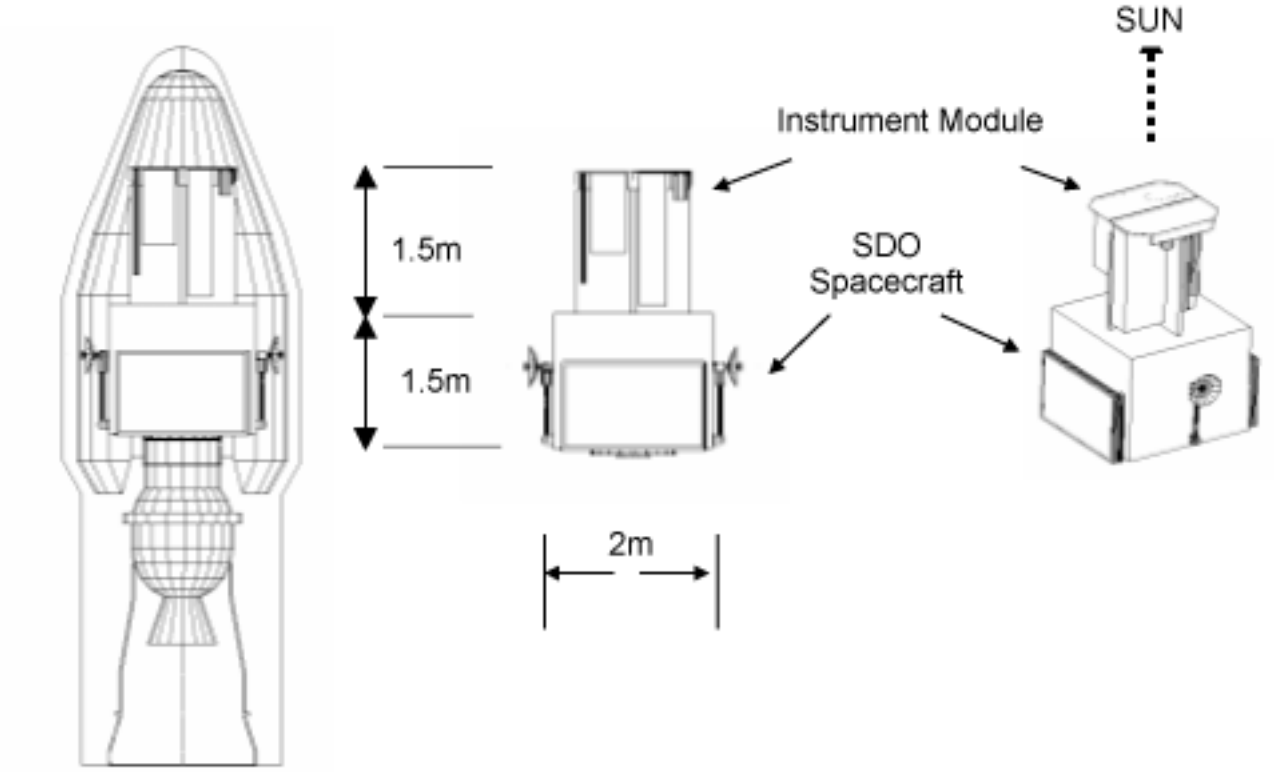
SDO
(Solar Dynamic Observatory)
&
NEXUS
(Normal Incidence Extreme-Ultraviolet Imaging Spectrometer)

国立天文台
渡邊鉄哉

National Astronomical Observatory of Japan 国立天文台

SDO Mission

Figure 5-1: Spacecraft Concept Sketch



National Astronomical Observatory of Japan 国立天文台

SDO Mission

- Geosynchronous Transfer Orbit (GTO)
- Inclination 28.5 deg
- Spacecraft Weight 225kg
- Launched by medium-class Expandable Launch Vehicle (ELV)
- 3-axis stabilized
- Maximum shadow period 1^{h}/day/eclipse
- Mission life 5 years

National Astronomical Observatory of Japan 国立天文台

Highest Priority Science Investigations

- A study of the origins of solar variability using solar oscillations and the longitudinal photospheric magnetic field to characterize and understand the Sun's interior and the various components of magnetic activity using data from what will be generically called a **Helioseismic and Magnetic Imager (HMI)** ;
- A study of coronal energy storage and release evidenced in rapidly evolving coronal structures over a broad temperature range that are intrinsically tied to the Sun's magnetic field and irradiance variations using data from what will be generically called an **Atmospheric Imaging Assembly (AIA)**;
- In concert with other anticipated observations of solar irradiance, a study of both the short- and long-term variations in the full-disk solar irradiance spectrum that arise in response to changes in the Sun's magnetic field, particularly in the extreme ultraviolet (EUV), and are known to cause changes in the Earth's upper atmosphere using data from what will be generically called a **Spectrometer for Irradiance in the EUV (SIE)**; and
- A study of the Sun's transient and steady state coronal plasma emissions that are driven by variations in the solar magnetic field using data from what will be generically called a **White-light Coronagraphic Imager (WCI)**.

National Astronomical Observatory of Japan 国立天文台

Other High Priority Science Investigations

- A study of physical processes involved in spectral irradiance variations and in impulsive and steady-state energy release in the solar atmosphere related to solar magnetic fields using data from what will be generically called an **Ultraviolet (UV)/EUV Imaging Spectrograph (UIS)** ;
- A study of the underlying origins of solar irradiance and luminosity variations and thermal structures associated with magnetic field structures using data from what will be generically called a **Photometric Imaging Telescope (PIT)**; and
- A study of magnetic stresses and current systems in the photosphere associated with impulsive events and evolving magnetic structures using data from what may possibly be an enhancement of the HMI and will be generically called the **Helioseismic and Vector Magnetic Imager (HVMI)**.

Table 5-4: Project Schedule with Milestones

Phase A	September 2002–May 2003
Initial Confirmation Review	May 2003
Phase B	May 2003–December 2003
Confirmation Review	December 2003
Phase C/D	December 2003–September 2007
Flight Instrument Delivery	June 2006
Launch	August 2007
Phase E	September 2007–August 2013

Table 5-1: Nominal Instrument Resources (Including Reserves)

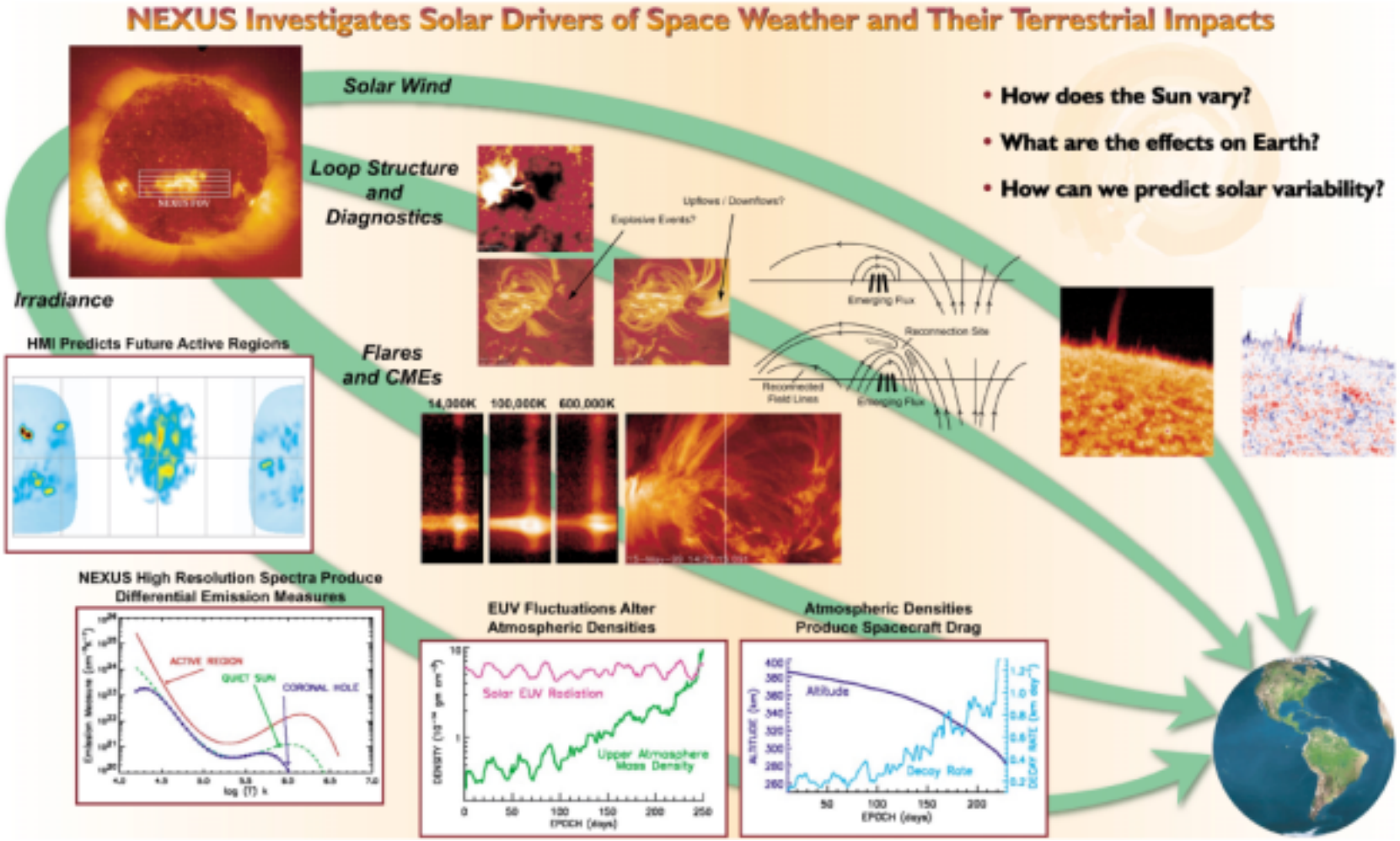
SDO Concept Instrument[□]	Mass (kg)	Average Power (Watts)	Data Rate (Mbps)	Envelope[*] (cm)	Remarks
HMI	54	57	29	90x40x25 sensor box 45x22x29 elec. box	
AIA[†]	66	140	58	100x15x25 sensor box 44x27x29 elec. box	Sensor box envelope is for single telescope
SIE	26	52	2	44x24x21 sensor box 25x23x18 elec. box	Sensor envelope is for single telescope
WCI	28	51	16	135x17x17 sensor box 25x23x18 elec. box	
UIS	58	63	23	150x50x50 sensor box 40x23x18 elec. box	
PIT	38	59	4	100x30 dia. sensor box 25x28x28 elec. box	
HVMI	63	78	55	70x40x35 sensor box 45x22x29 elec. box	Replaces HMI if selected
Concept Instrument Total	279	443	158		AIA, SIE, WCI, UIS. PIT, and HVMI
Baseline Spacecraft Capability[‡]	225	350	150		For all instruments including reserve

[□] Note: See instrument definitions in Section 1.2
[*] Note: First dimension is the Sun-pointing direction.
[†] Note: AIA mass, power, and telemetry are for a 5-telescope array.
[‡] Note: Spacecraft baseline cannot support full instrument complement as presented.

National Astronomical Observatory of Japan
国立天文台

NEXUS

(Normal Incidence Extreme-Ultraviolet Imaging Spectrograph)



National Astronomical Observatory of Japan
国立天文台

NEXUS

(Normal Incidence Extreme-Ultraviolet Imaging Spectrograph)

Table 1-1. NEXUS Observational Capabilities

Spatial resolution	1 arcsec per 2 pixels
Field of view (slit)	0.5x1100 arcsec
Field of view (slot)	60x1100 arcsec
Wavelength bands	457-525, 566-631, 743-800 Å
Resolving power	15000
Cadence (active regions)	1 s
Cadence (quiet sun)	8 s
Dynamic range	S/N >10
Velocity resolution	better than 1-2 km s^{-1}
Temperature coverage	$2x10^4$–$1.5x10^7$ K

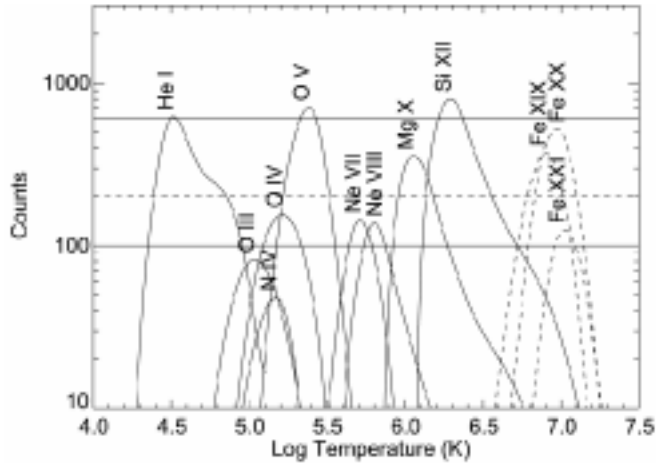


Table 1-2. NEXUS Strongest Spectral Lines

Ion	λ (Å)	log T (MK)	Detected Photons in 0.5" Slit per Second		
			Quiet Sun	Active Region	M1 Flare
Ne VII	465.220	5.71	13.3	143.7	1317.
Si XII	499.407	6.28	17.3	796.6	24604.
Si XII	520.666	6.28	8.9	409.8	12699.
Fe XX	567.864	6.97	0.0	0.2	5053.
Al XI	568.122	6.16	1.6	54.5	520.
He I	584.334	4.51	71.4	614.0	78793.
Fe XXI	585.790	7.02	0.0	0.0	1217.
Fe XIX	592.236	6.90	0.0	0.9	3715.
O III	599.601	5.03	13.1	79.6	13356.
2x He II	607.560		3.6	23.4	12608.
Mg X	609.794	6.05	24.7	668.2	6696.
O IV	609.832	5.21	9.1	63.8	7344.
Mg X	624.943	6.05	12.1	327.2	3252.
O V	629.730	5.38	86.3	693.0	46338.
Ne VIII	770.410	5.80	8.1	137.9	809.
Ne VIII	780.325	5.80	4.4	74.6	438.
O IV	787.713	5.21	10.7	75.7	9257.
O IV	790.203	5.21	19.9	139.8	17076.

National Astronomical Observatory of Japan 国立天文台

NEXUS

(Normal Incidence Extreme-Ultraviolet Imaging Spectrograph)

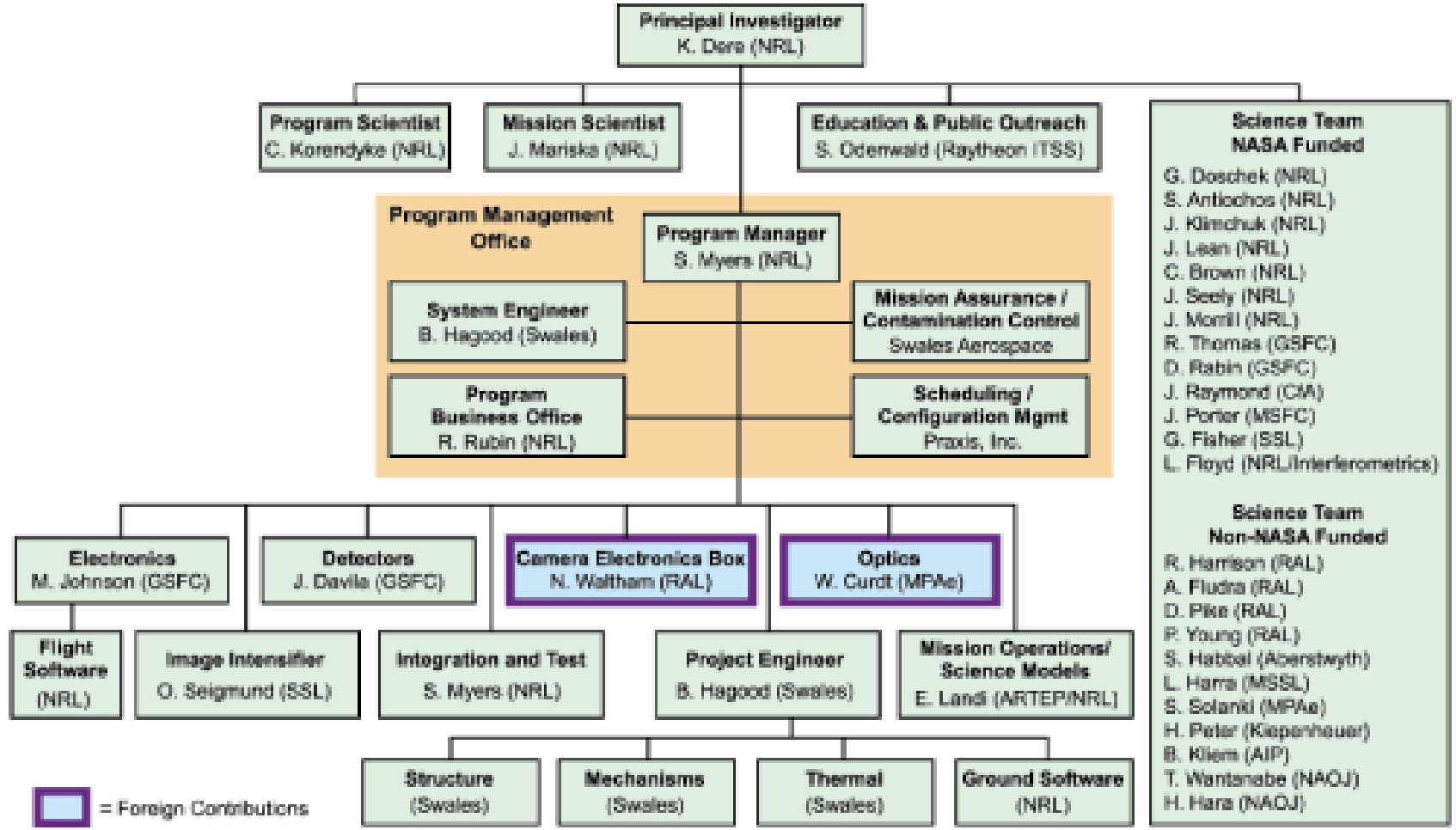


Figure 5-1. NEXUS Integrated Product Development Team (IPDT) Organization

National Astronomical Observatory of Japan
国立天文台

NEXUS

(Normal Incidence Extreme-Ultraviolet Imaging Spectrograph)

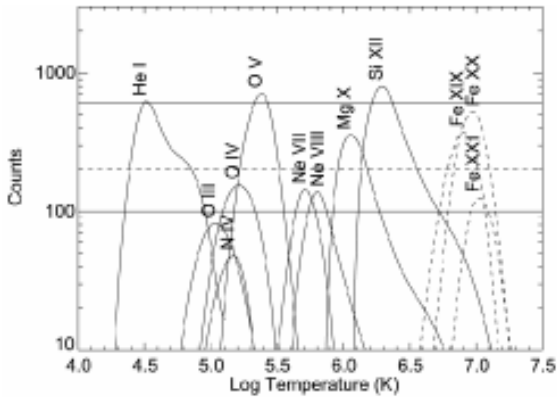


Table 2-2. NEXUS Optical Design Parameters

Number of reflections	2
Spectral bandpass A	457-525 Å
Spectral bandpass B	566-631 Å
Spectral bandpass C	743-800 Å
Aperture dimensions	100 x 100 mm
Telescope dimensions	108 x 102 mm
Telescope vertex offset	70 mm
Telescope focal length	1176 mm
Slit to grating distance	224 mm
Total instr optical length	1400 mm
Total instr optical width	368 mm
Total instr optical height	108 mm
Slot/slit width	342/3.0 µm =>60/0.5 arcsec
Slot/slit length	6.2 mm
Grating dimensions	21.0 x 25.0 mm
Grating sagittal radius	377.035 mm
Grating tangential radius	375.000 mm
Grating Alpha angle	1.105 deg
Grating central ruling density	3400 gr/mm
Grating TVLS parameter b2	0.052859 *
Grating TVLS parameter b3	0.040301
Grating TVLS parameter b4	0.339541 *
Grating blaze wavelength	500 Å
Grating blaze angle	4.90 deg
Mid Grating to focus dist	1270.9 mm
Mid Spectrum magnification	5.67
Avg spectral dispersion	1.934 A/mm =>32.9 mA/pix
Mid spatial plate scale	32.3 µm/arcsec =>0.526 arcsec/pix
Full spatial field of view	1080 arcsec (18.0 arcmin)

* The sign convention for parameters b2 & b4 requires that the slit be on the +Y side of grating normal, and that the grating's blaze facets also be tilted in the +Y direction.

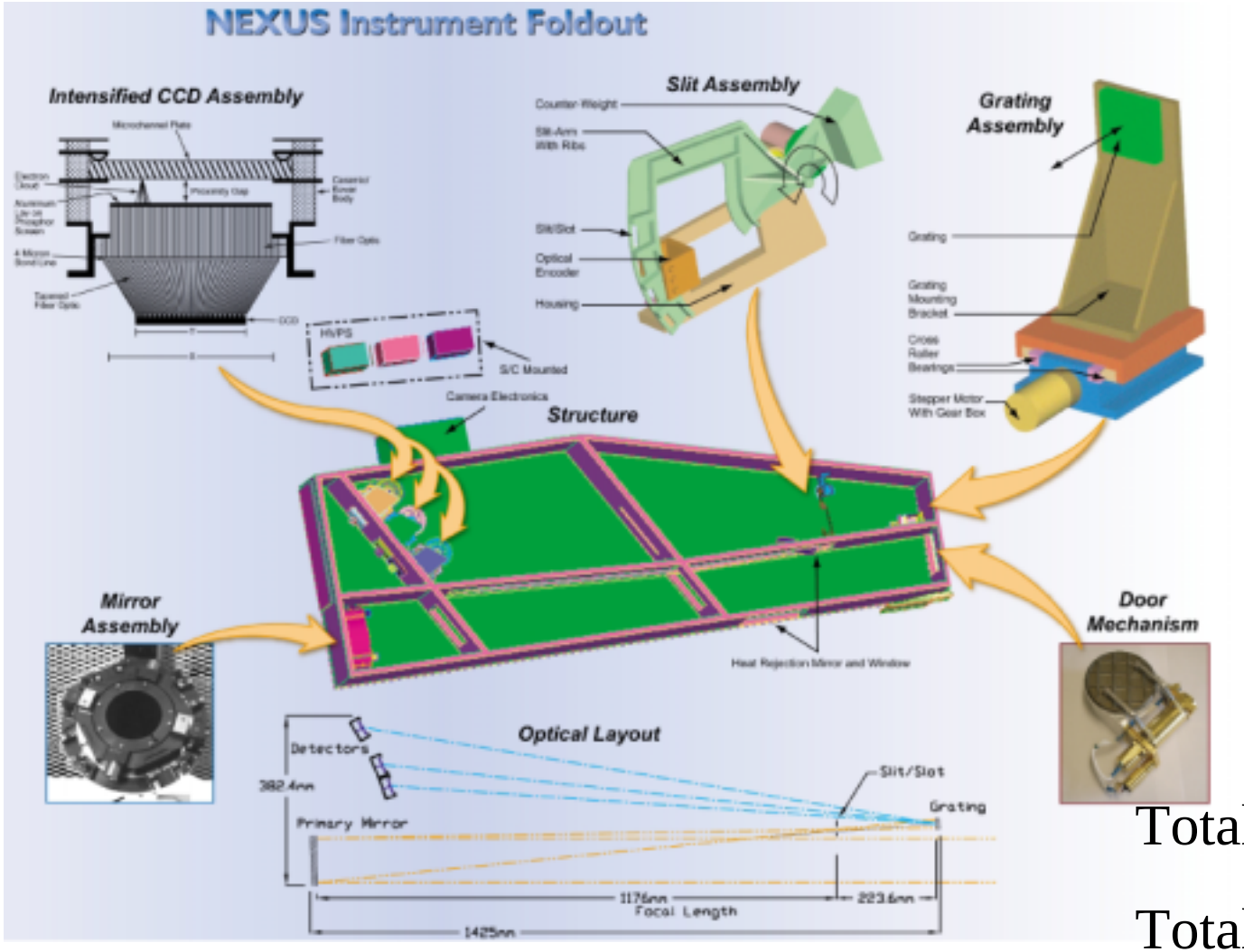
Table 2-1. NEXUS Instrument Characteristics

Telescope	Nominal Characteristic
Type	Off-axis paraboloid telescope
Focal length	140 cm
Aperture	10 cm
Off-axis distance	2.5 cm
Rastered image quality	<1 arcsec over ___ of the sun
Plate scale	7 microns/arcsec
Optic substrate and coating	Zerodur, Ir-B_4C multilayer coating
Articulation	±1200 arcsec image motion
Image motion compensation	Rejection of 0.2 arcsec disturbance at 50 Hz
Slit Exchange Mechanism	Nominal Characteristic
Slit height	1024 arcsec
Slit width	0.5, 1.0 and 2.0 arcsec wide slits, 60 arcsec slot
Grating Spectrograph	Nominal Characteristic
Type	Modified Rowland circle spectrograph
Grating	Toroidal blank, variable line spaced, blazed @ 600 Å
Coating	Ir-B_4C multilayer coating
Nominal groove density	3600 lines/mm
Focus mechanism range	±8 mm
Operating order	1st
Magnification	4.85
Plate scale	Nominal 34 microns/arcsec
Dispersion	Nominal: 1.7 A/mm, 29 mA/pixel, 15 km/s @ 600 A
Wavelength coverage	Detector 1: 454-522 Å Detector 2: 570-630 Å Detector 3: 750-800 Å
Detector	Nominal Characteristic
Type	Intensified CCD
Intensifier characteristics	6 micron pore microchannel plate intensifier, active area 34.8 mm square, KBr photocathode, P40 output phosphor onto a fiber optic block
Projected pixel size	Projected CCD pixel size at instrument face plate: 17 microns or 0.5 arcsec
Comparable intensified CCD imaging performance to a backside illuminated CCD imaging performance	20 microns at the face plate 0.6 arcsec/pixel
Coupling characteristics	Tapered fiber optic coupling from a 17 micron pixel to a 13.5 micron CCD pixel

National Astronomical Observatory of Japan
国立天文台

NEXUS

(Normal Incidence Extreme-Ultraviolet Imaging Spectrograph)



Total Weight 38.25 kg

Total Power 53.5 W

National Astronomical Observatory of Japan
国立天文台

NEXUS

(Normal Incidence Extreme-Ultraviolet Imaging Spectrograph)