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Integrated Science Instrument Module (ISIM)

Presentation to the
Society of Photo-Optical Instrumentation Engineers
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Mission

NGST Integrated Science Instrument Module

- What is it?
- Development Approach
- Instrument Technology Development
- Cost & Schedule

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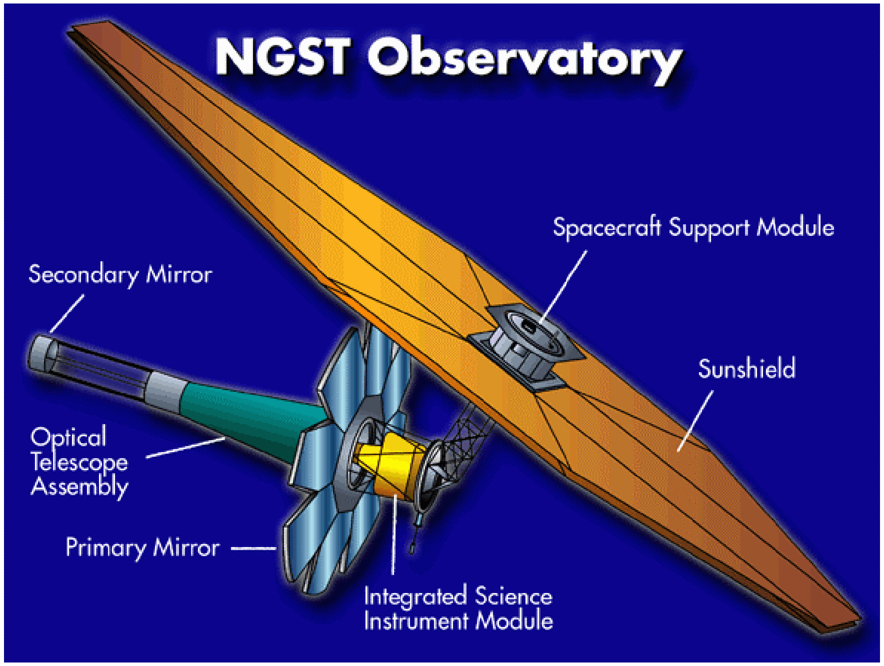
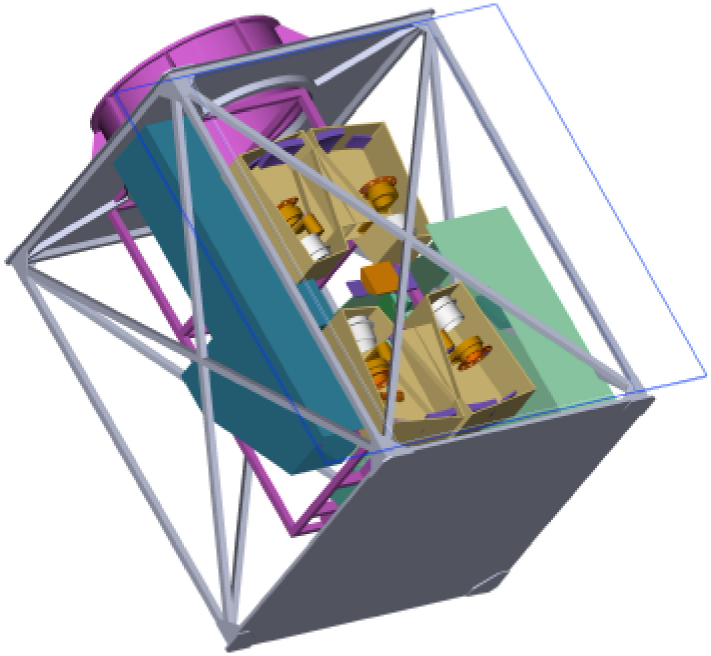
NGST Integrated Science Instrument Module

- One of three major subsystems that comprise NGST
- The ISIM system consists of a cold instrument module and a data system located in the SSM
- The cold instrument module contains:
    - OTA optics
    - US, European, and Canadian science instruments
    - Support systems (thermal, electronic, etc)



NGST Yardstick OTA, ISIM, and SSM



Yardstick Integrated Science Instrument Module

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ISIM Development

- GSFC will lead an IPT for development of the ISIM
  - members include: STScI, ESA, CSA, Prime Contractor, Science Instrument PIs
    - IPT Lead: Paul Geithner (GSFC)

- Science instruments for ISIM procured from US, European, and Canadian science communities and delivered to GSFC for integration into ISIM

- ISIM system integrated at GSFC and delivered to prime contractor as GFE

ISIM IPT During NGST Phase 1 (Jul 99 – Mar 01)

NGST

- Objectives:
  - Produce conceptual ISIM designs for two competing observatory architectures.
  - Fund and manage development of instrument technologies that enable performance, reduce risk, and enhance cost efficiency.
  - Develop ISIM and science instrument cost and schedule estimates.
  - Develop ISIM and science instrument performance and interface requirements.
- Phase 1 ISIM activities are organized into 3 design cycles:
  - Cycle 1: settle observatory level trades that effect ISIM and yield preliminary ISIM architectures for each observatory architectures.
  - Cycle 2: settle all ISIM trades; define and cost ISIM conceptual design for each prime contractor architecture.
  - Cycle 3: finalize interfaces; conclude ISIM conceptual design, prepare for instrument solicitation.

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Science Instruments During Phase 1

- ISIM design activities are governed by:
  - DRM science requirements
  - ASWG recommended baseline instrument requirements
  - Detailed strawman instrument designs that meet these requirements
    - ensure adequate allocation of instrument resources (e.g. mass, volume, power, etc)
  - Prime contractor observatory architecture requirements
  - Science center operations requirements

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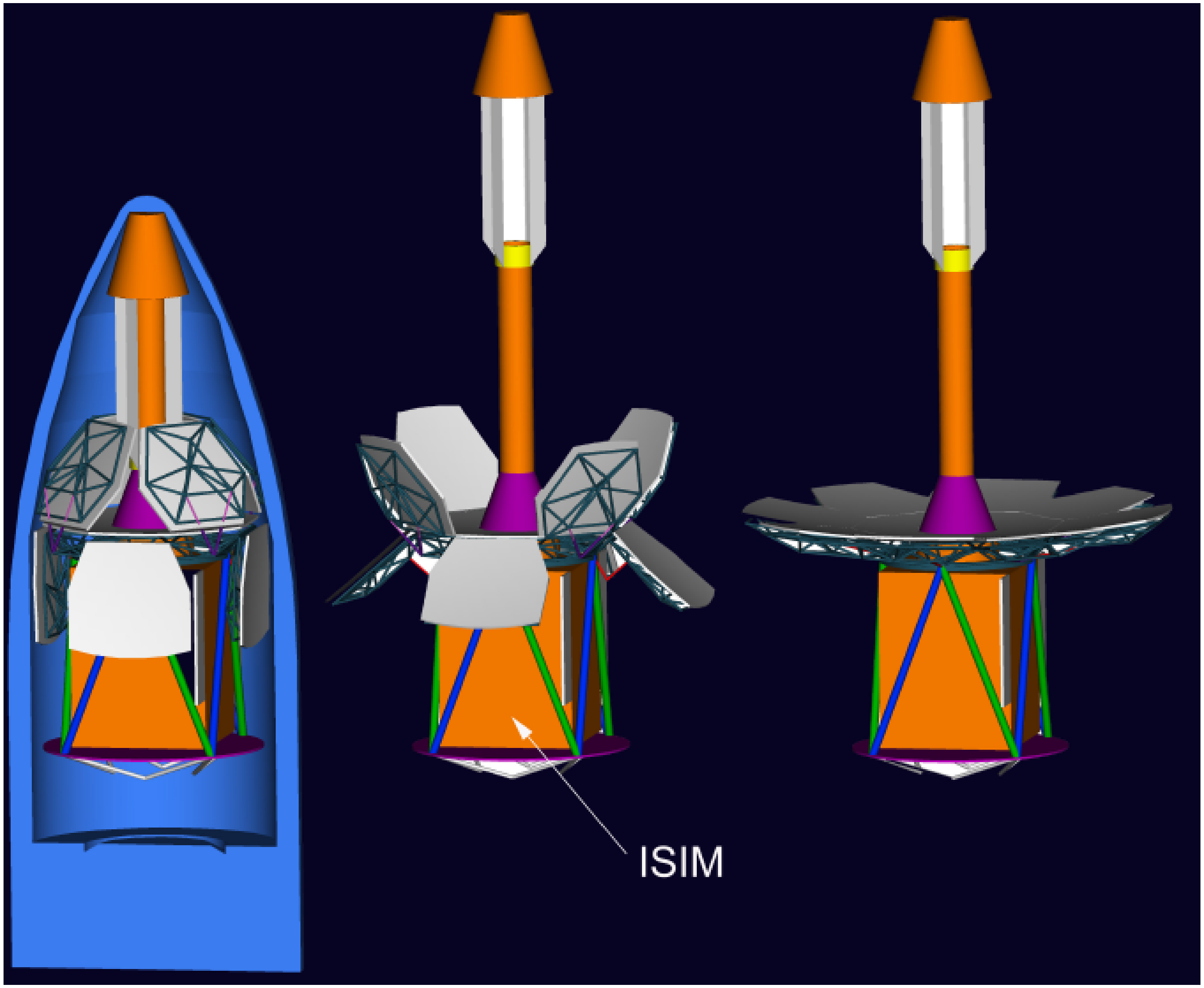
NGST 8m: EELV Medium 5m Fairing



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Baseline Instrument Suite

- NIR Camera: 64 mega pixels, 16 sq arc-min FOV
  - Nyquist sampled at 2 µm, 0.6-5 µm wavelength coverage
- NIR MOS: *R*~100 & 1000, 9 sq arc-min FOV
  - >100 simultaneous source spectra, 1-5 µm wavelength coverage
    - MOS capability not required in R~100 mode; implementation of this mode in camera via single slit dispersion is acceptable alternative.
  - 16 mega pixel FPA
- MIR Camera/Spectrometer: 4 sq arc-min FOV
  - Nyquist sampled at ~10 µm, 5-28 µm imagery
  - R~1500 long slit spectroscopy
  - 1 mega pixel FPA

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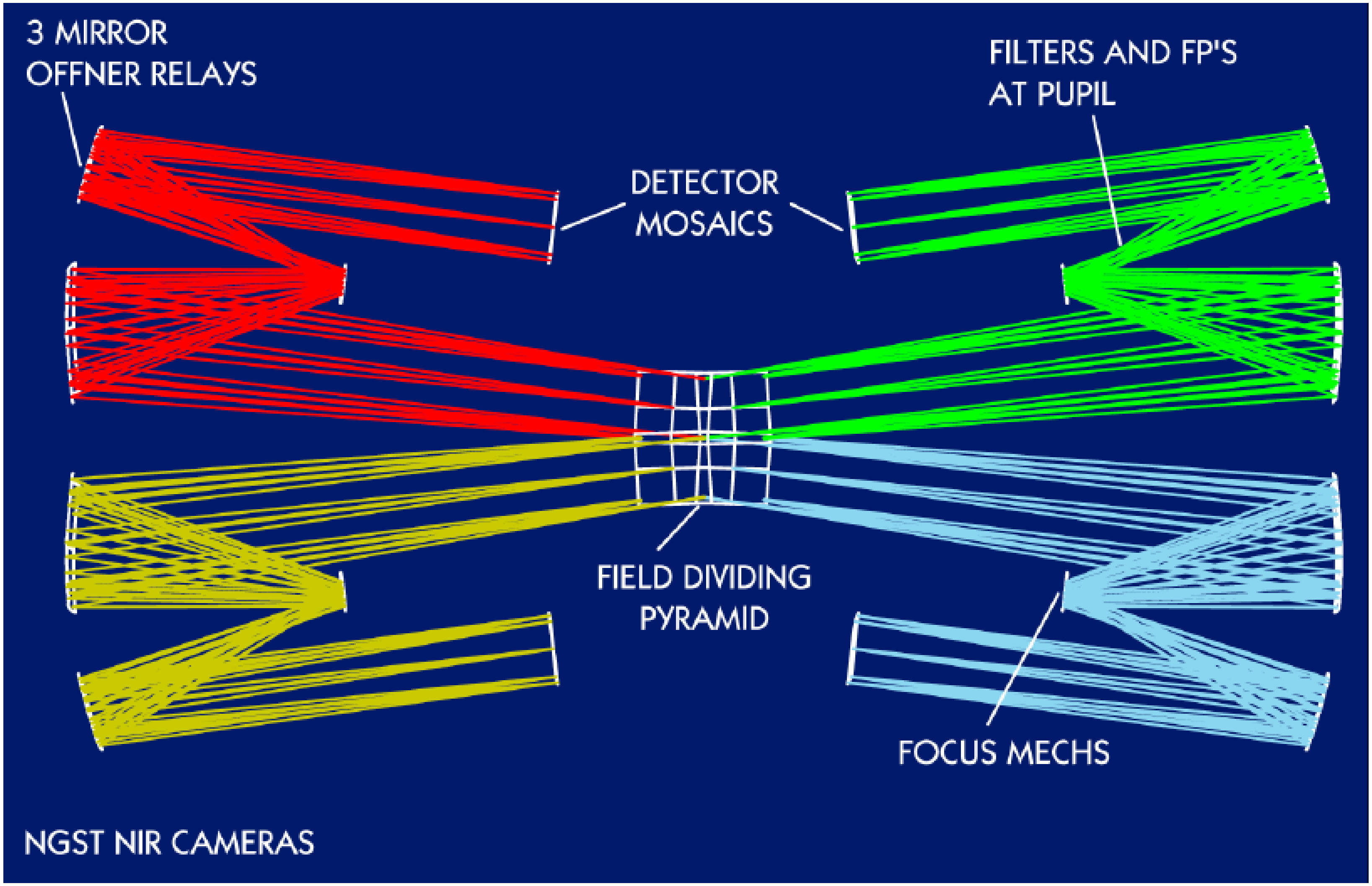
Yardstick NIR Wide Field Camera Optical Schematic



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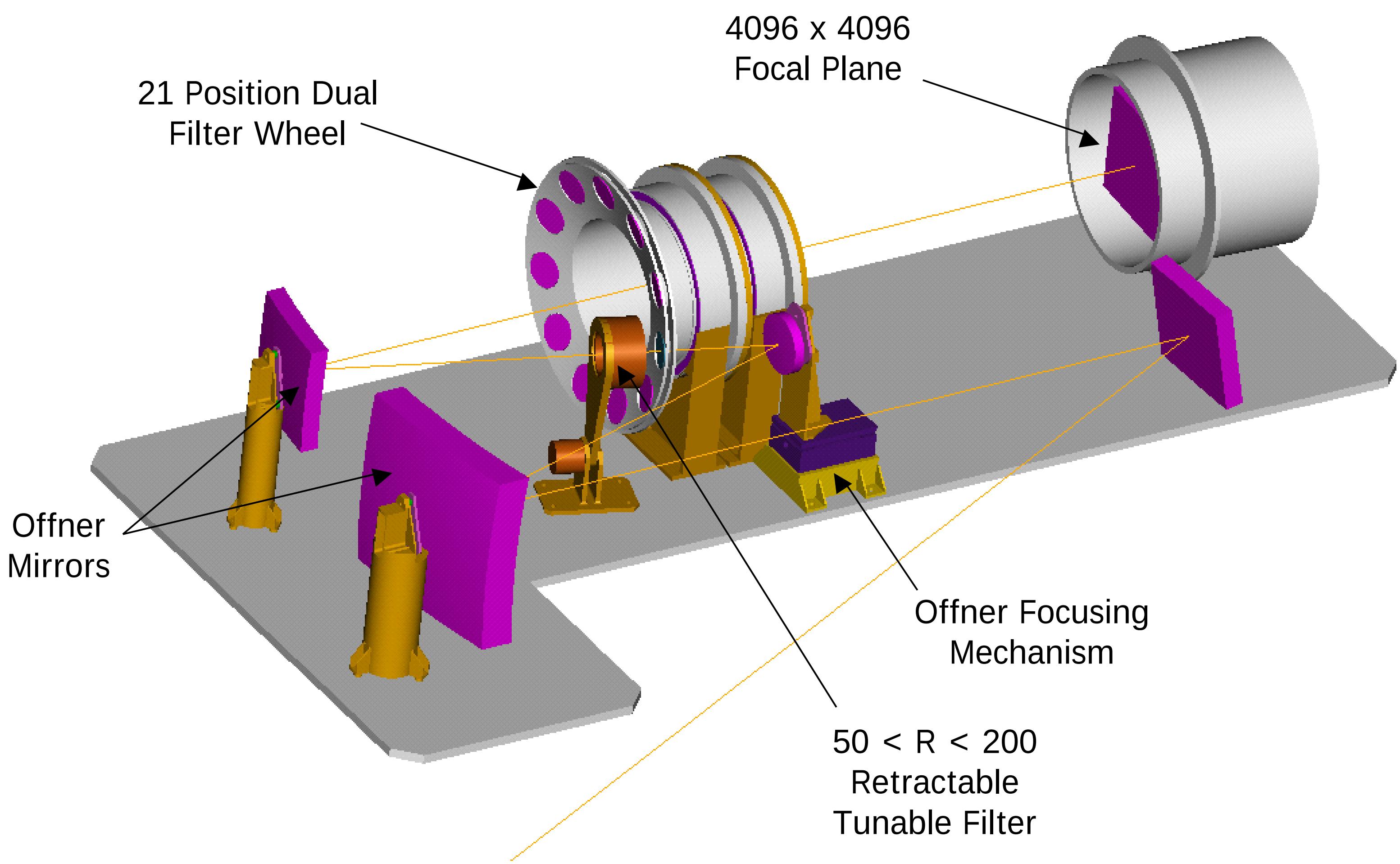
NIR Camera Module: 1 of 4



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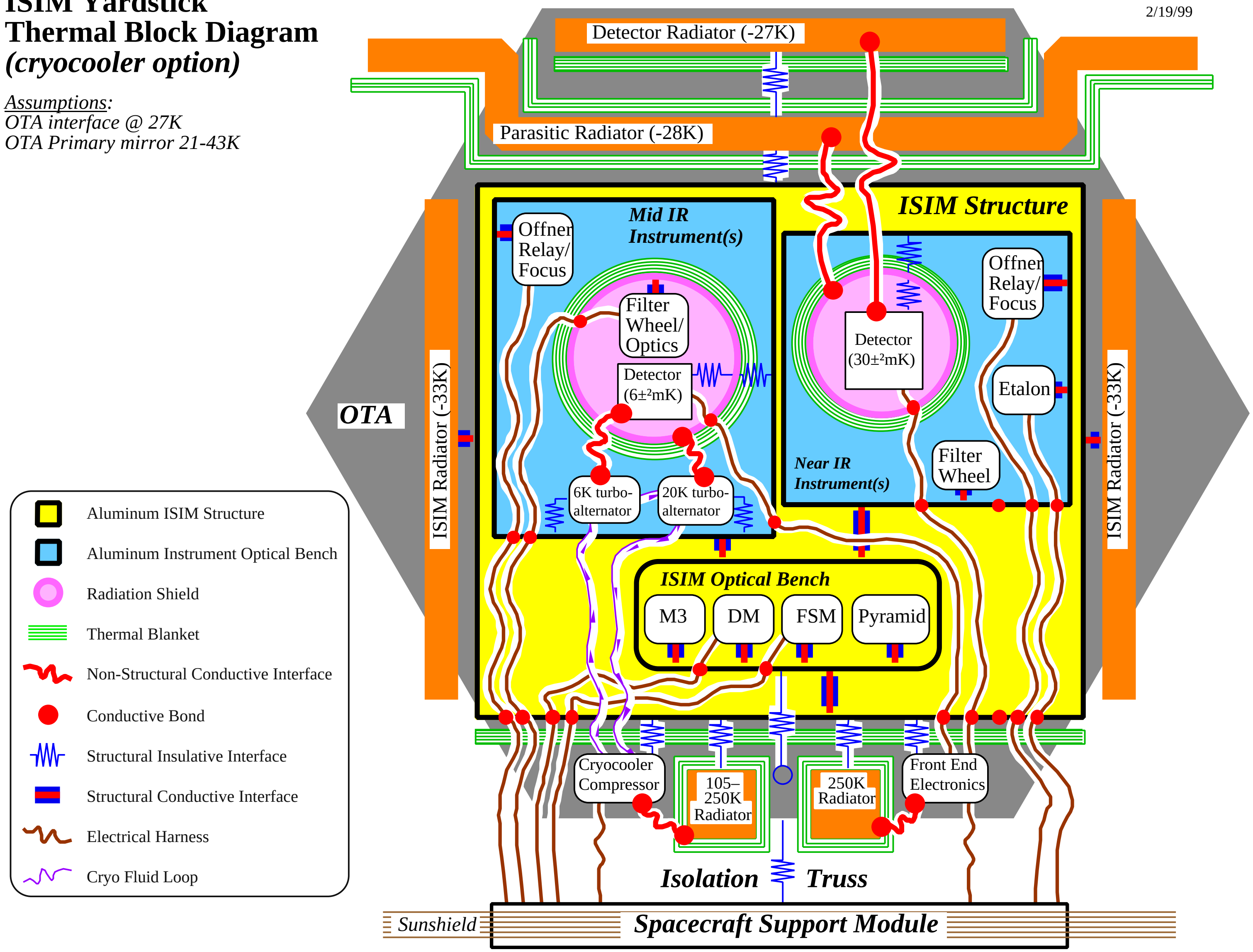
ISIM Yardstick Thermal Block Diagram *(cryocooler option)*

Assumptions:
OTA interface @ 27K
OTA Primary mirror 21-43K

Jon Lawrence
2/19/99



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Flight Data System (FDS) Hardware

- Two primary computer systems
  - Support Systems Module (SSM) Computer
  - Integrated Science Instrument Module (ISIM) Computer
    - **ISIM computer shared by 3 science instruments**

- Common COTS Computer System for ISIM and SSM
  - RAD 750 processors
    - produced by JPL X2000 program
      - equivalent to Power PC 150 MHz CPU
      - No NGST technology development required
  - All subsystems communicate with the computer using the PCI bus standard
- Full Hardware Redundancy
- ISIM computer system may contain custom PI supplied I/F components.

Flight Data System Hardware Environment

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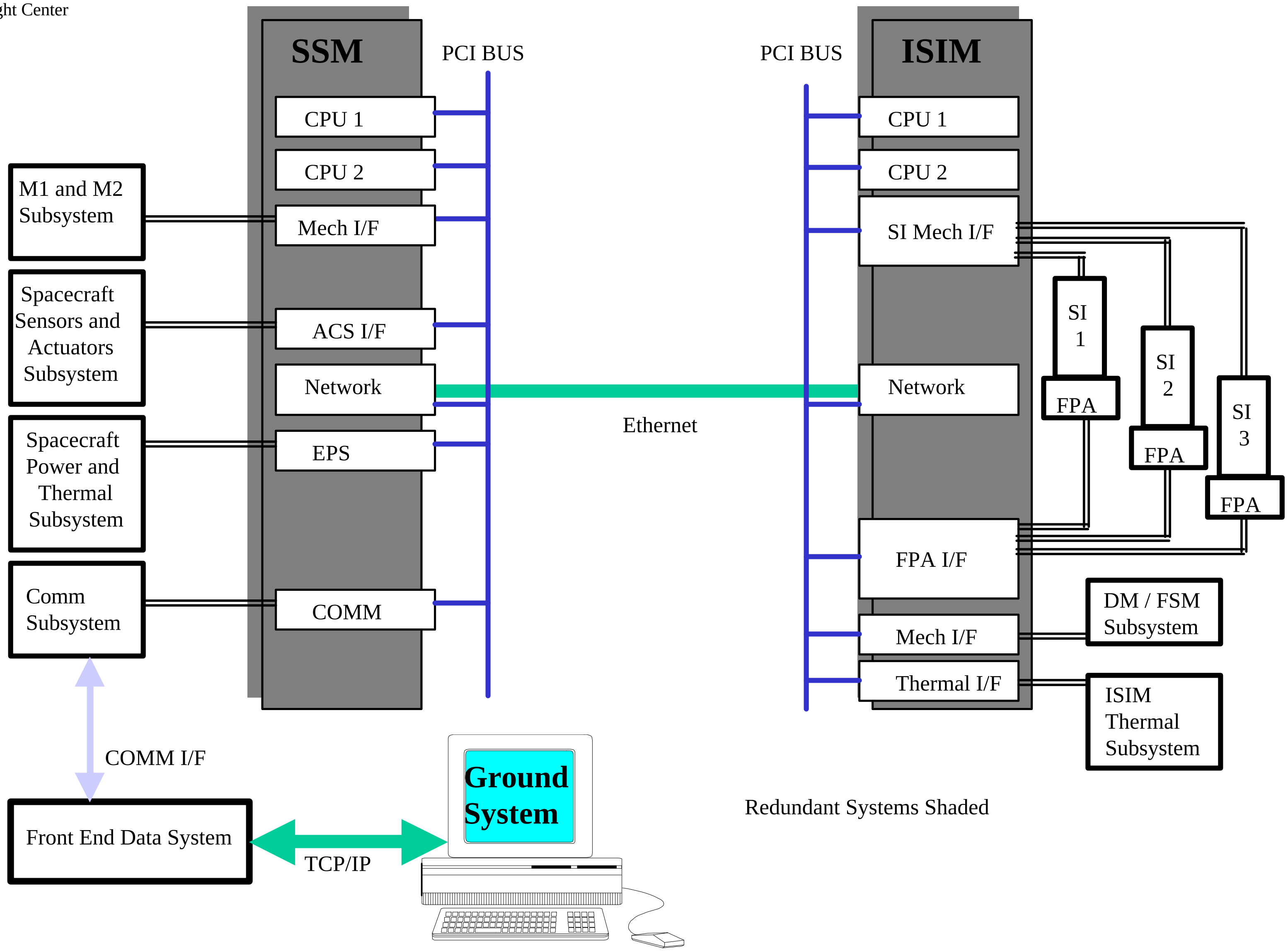

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Instrument Technology Development

- Several instrument technology development projects were started during the pre-Phase A ISIM program.
  - Focused on Yardstick instruments.
- Project goals
  - risk and challenge assessment
    - proof of concept demonstrations
  - develop basis for cost and schedule estimate
- Focus areas included:
  - detectors (see talk by Craig McCreight: 4013-92)
  - micro-mirrors (see talk by John Mackenty: 4013-96)
  - tunable filters (see talk by Shobita Satyapal: 4013:100)

The NGST Mission Requires Five 16 Mpixel NIR FPAs and a 1 Mpixel Si:As FPA

NGST

Challenge areas:

5x reduction in read noise
10x reduction in dark current } NIR
FPA packaging & SCA yield

	T (K)	QE	Read Noise (e) multiple	Dark Current (e/s)
SIRTF InSb	15	0.9	7	0.1
NIR goal	30	>0.9	<1.5	<0.01
SIRTF Si:As	6	0.6	10	<1
MIR goal	8	>0.8	<9	<0.1

4096^2 fully functional cryogenic mux assembly

Detector Development Programs Underway

l (mm)	Investigators	Technology
0.6 – 5	U. Rochester & Raytheon IRCoE	InSb
0.6 – 5	U. Hawaii & Rockwell Science Center	HgCdTe
5 – 28	ARC & Cornell U. & Raytheon IRCoE	Si:As

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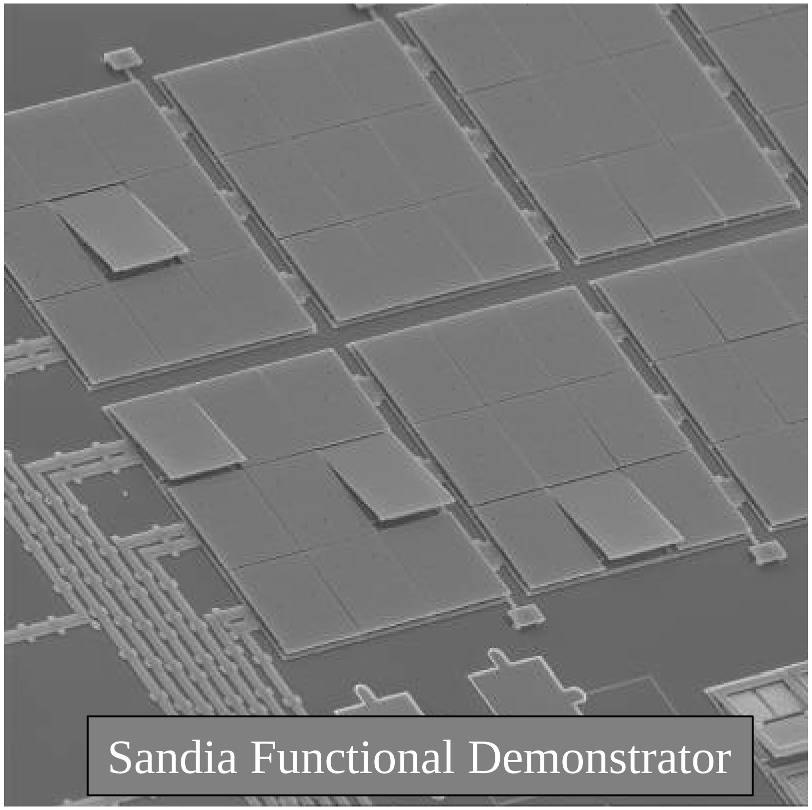
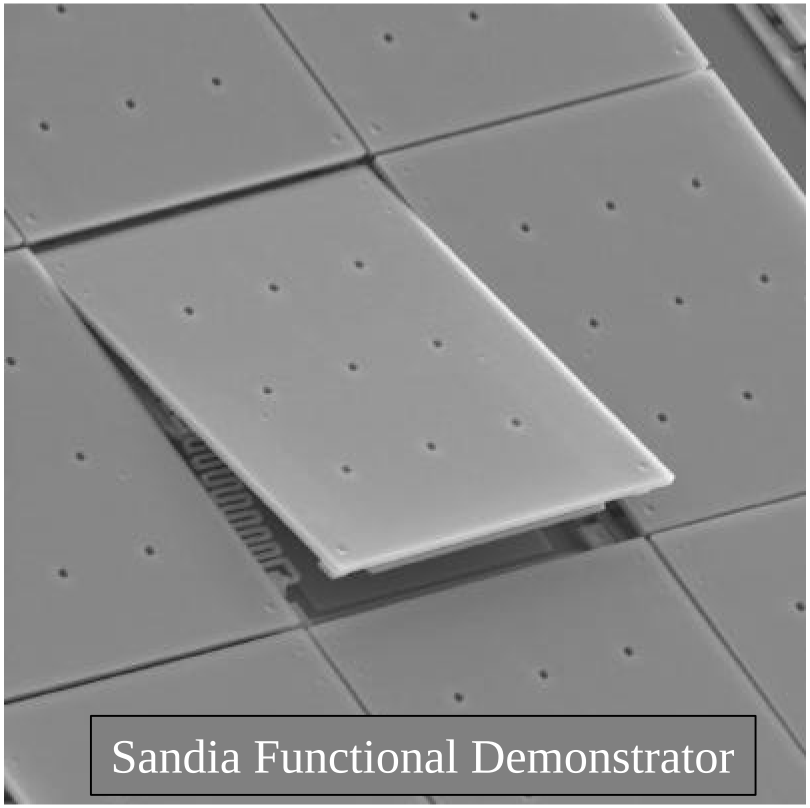
MEMS Aperture Control for Multi-Object Spectroscopy Programmable Reflective Slit Mask

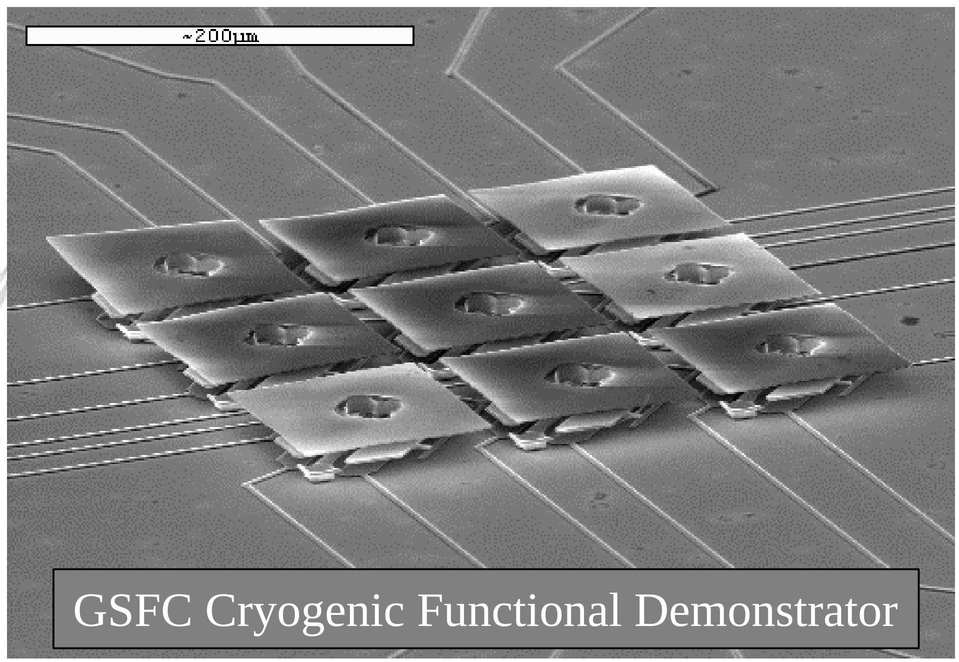
- Sandia National Laboratories
  - all silicon design, 100 micron pixels
  - designed for NGST 30K environment
  - 3 x 3 pixel prototypes produced for NGST on commercial fab line



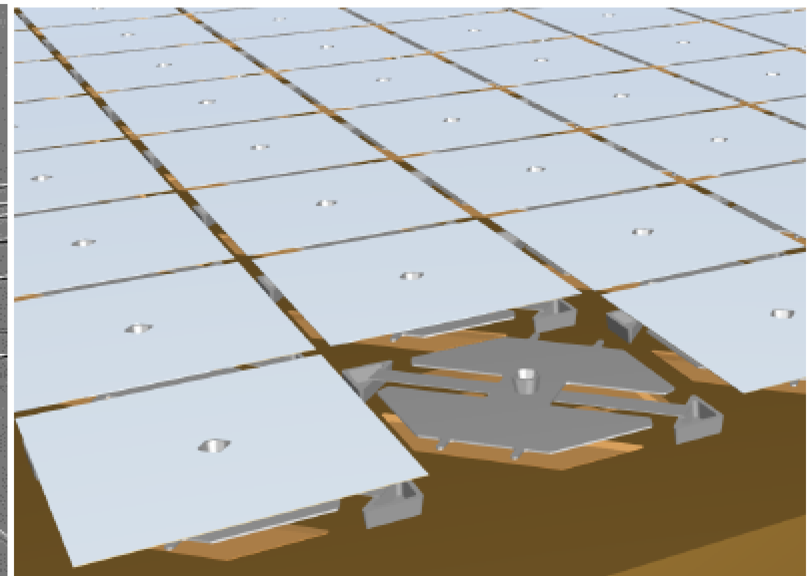


MEMS Aperture Control for Multi-Object Spectroscopy
Programmable Reflective Slit Mask

- Goddard Space Flight Center
  - – all aluminum design, 100 micron pixels
  - – designed for NGST 30K environment
  - – 3 x 3 pixel prototypes, cryogenic operation demonstrated
  - – http://repentium.gsfc.nasa.gov/~dsb/718etc.html



GSFC Cryogenic Functional Demonstrator


GSFC Artist's Concept

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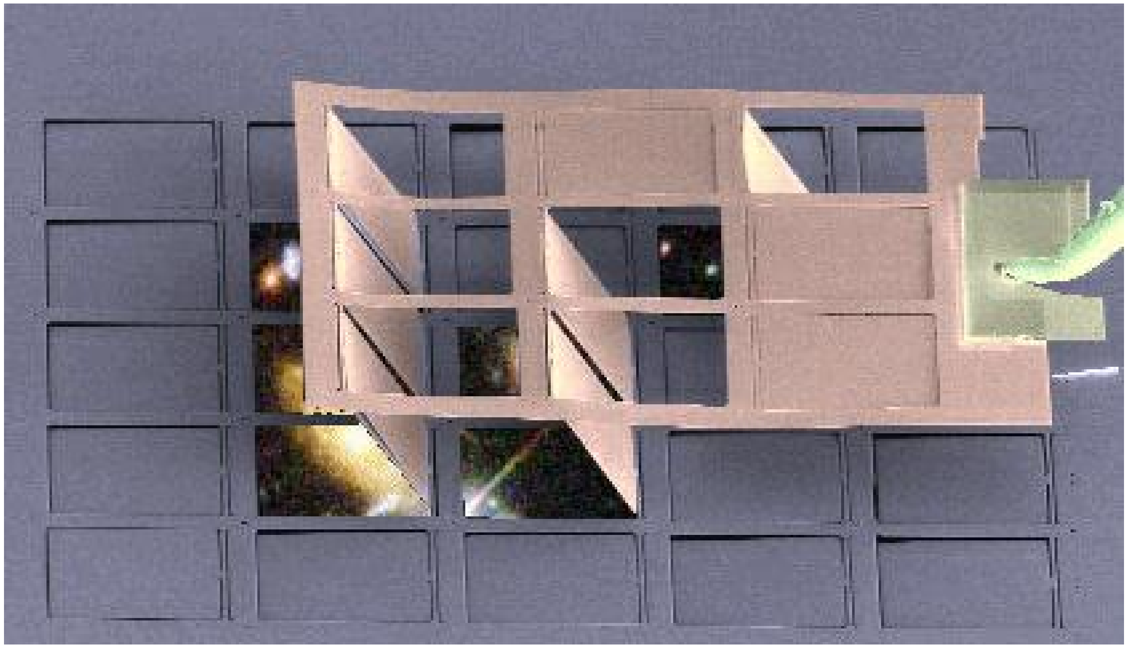
MEMS Aperture Control for Multi-Object Spectroscopy
Programmable Transmissive Slit Mask

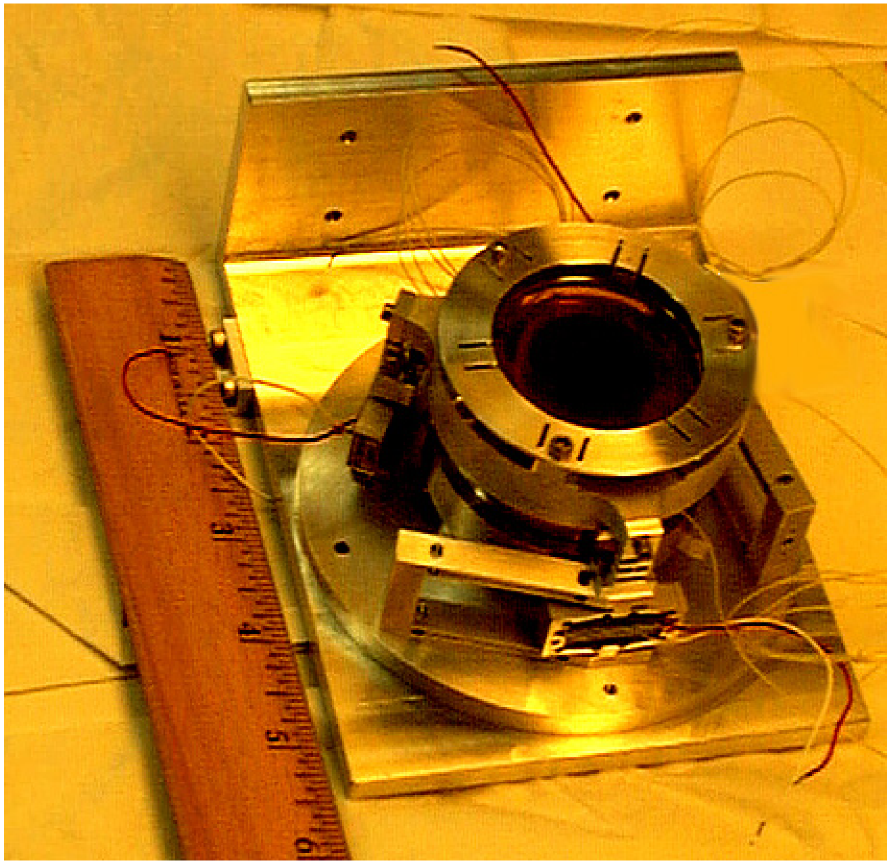
- Goddard Space Flight Center
  - designed for NGST 30K environment
  - small format prototypes produced by focused ion milling
  - http://bennet.gsfc.nasa.gov/ms_webpage/ms_animation.html

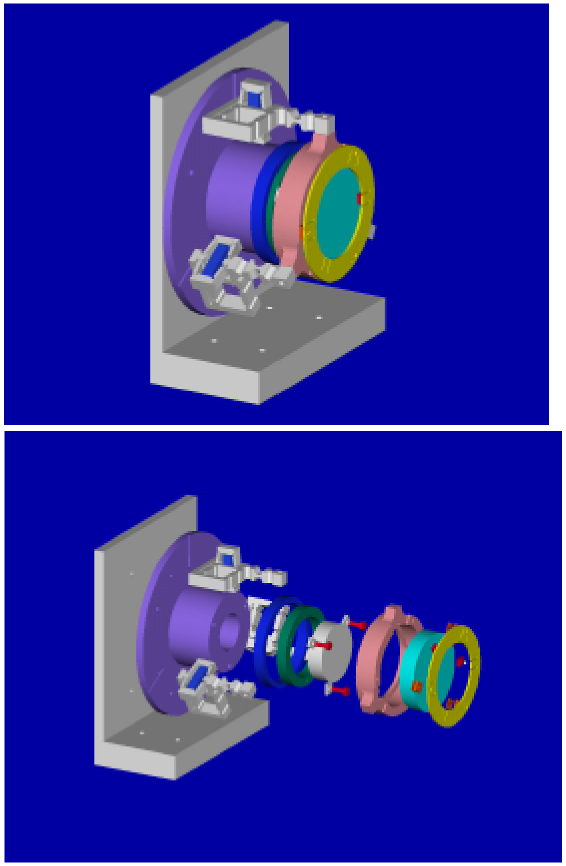


GSFC Functional Concept Demonstrator

Demonstrator Unit for Low Order Cryogenic Etalon (DULCE)

- Prototype tunable filter for NGST wide field imagery
- 1 – 5 µm continuous coverage, 50 < R < 200
- Alternative to large filter inventory for narrow-band imagery





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NGST Science Instrument Technology Development (SITD) NRA

- Available now on OSS Research Opportunities Web Site
  - NOI due 7 April, proposals due 5 May
- Total program budgeted at $5M per year for two years
- Topics include:
  - Enabling technologies for multi-object and integral field spectroscopy
  - Laboratory and ground-based performance demonstrations of NGST science instrument concepts
    - Instruments that would facilitate on-telescope low background power testing of NGST prototype detectors are of specific interest.
  - Techniques for characterization and operation of detectors such as:
    - development of components and techniques for very low power dissipation digitization of detector signals
    - techniques for working in ultra-low background power detector test environments
- Cryo-Coolers to be funded by separate program
  - Advanced Cryo-Cooler System Demonstrator (ACSD)
  - GSFC RfO available late spring 2000

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ISIM Cost Constraints

ISIM phase CD cost cap = $225M FY96

~ 30% of NGST CD mission budget (NASA, ESA, CSA combined)

Phase CD ISIM Cost Data $M FY96 V10200

	1	2	3	4	5
	Shared Instrument Systems	NIR Camera	NIR MOS	MIR Cam/Spec	Total
Grass Roots	65.8	31.6	26.5	27.4	151.3
35% Contingency	23.0	11.1	9.3	9.6	53
10% Fee	8.9	4.3	3.6	3.7	20.5
Total	**97.7**	**47.0**	**39.4**	**40.7**	**225**

Column Notes:

- 1 – system level I&T
  - flight data system hardware
  - flight software
  - data system GSE to each SI & prime contractor
  - flight structure
  - power & harness
  - all radiators or alternate thermal control for NIR
  - cryo-rated opto-mechanical-power simulator for each SI
- 2, 3 – all NIR cooling costs included in (1)
- 4 – includes MIR cooling costs
- 5 – uncertainty estimated as +/- 20%

Next ISIM cost : Oct 00
Includes:
- detailed PERT network
- detailed engineering design

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ISIM Development Timeline: Version 4.1

Selected ISIM Milestones	CY	Month	ISIM	NGST	NGST Milestones
		6		Phase A	
Design Cycle 1		7	Cycle 1		Formulation Phase 1: two primes selected
		8			
		9			
		10			
		11			
		12			
	2000	1			
SITD NRA released		2			ESA CSA Instrument Allocation
		3			
Design Cycle 2		4	Cycle 2		
Detector cost study contracts issued		5			
Detector mantech contracts issued		6			
SITD NRA awards issued		7			
Cryo-Cooler phase 1 study contracts issued		8			
		9			
ISIM cost estimate update		10		Phase B	
		11			
		12			
Design Cycle 3	2001	1	Cycle 3		
Cryo-Cooler phase 2 study contracts issued		2			
		3			
		4			
NIR SCA Guide Mode Test Results		5			
		6			
		7			Formulation Phase 2: single prime selected
		8			
SITD Year 1 Performance Review		9			
		10			
		11			
		12			
2nd community workshop on detectors	2002	1			
		2			20% Systems Requirements Review (SRR)
Science instrument draft AO available		3			
Pre-proposal workshop		4			
Science instrument AO released		5			
		6			
		7			
		8			
		9			
		10			
Science instrument and SWG selection		11			
Flight detector RfP released		12			
				on going	

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US Instrument Development Timeline: Version 4.1

Selected ISIM Milestones	CY	Quarter	ISIM	SI	NGST	NGST Milestones
	1999	2				
Woods Hole meeting		3	Cycle		Phase	Formulation phase 1: 2 primes selected
		4	1		A	
SITD NRA available	2000	1				
		2	Cycle			
SITD NRA awards, Cryo-cooler phase 1		3	2			
ISIM cost update		4			Phase	
	2001	1	Cycle		B	
		2	3			
		3				Formulation phase 2: prime downselect
		4	Phase			
Cryo-Cooler phase 2 contracts	2002	1	AB			20% SRR
Instrument AO released		2				
		3				
Instrument & SWG selection complete		4		Phase		
	2003	1		AB		
Flight detector selection complete		2				
		3				
SI PDR		4				
	2004	1				NAR
		2			Phase	
		3			CD	
SI CDR		4	Phase	Phase		Observatory CDR
	2005	1	CD	CD		
		2				
		3				
Flight Detector FPAs Delivered To SIs		4				
	2006	1				
		2		I&T		
		3				
SIs Delivered TO GSFC		4	I&T			
	2007	1				
		2				
ISIM Delivered To Prime		3				
		4			I&T	
	2008	1				
		2				
		3				
		4				Launch site integration
	2009	1			Reserve	
Launch Readiness		2				