ISCEA Infrared SmallSat for Cluster Evolution Astrophysics

Exploring Cosmic Evolution at the Peak of Galaxy Formation

ISCEA Science Goal

Discover how Galaxies Formed and Evolved in the Cosmic Web of Dark Matter

***ISCEA* addresses the fundamental questions of how and on what timescale the environment in which a galaxy resides regulates its growth and star formation history, and determines its observed morphology**

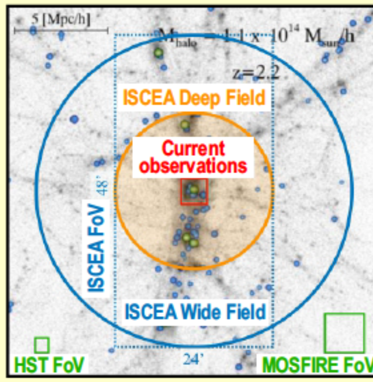
ISCEA Science Objectives

1) Study galaxy evolution in dense environments at the peak of galaxy formation

- 22 Galaxy clusters with mass > 10^{14} $M_\odot$
- 140 Galaxies in each cluster with S/N ≥ 5 spectra
- 140 Galaxies in each cluster with Δv<100 km/sec velocity measurements

2) Map the cosmic web environment around clusters at this critical epoch

- 500 Galaxies around each cluster with S/N ≥5 spectra
- 500 Galaxies around each cluster with Δv <100 km/sec velocity measurements

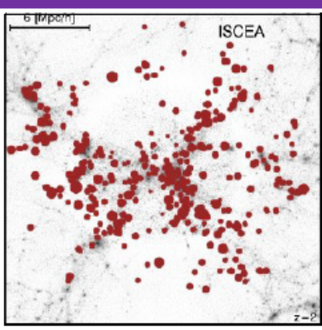


ISCEA FoV (large dotted blue box) compared to current observations (small red square), and FoV of HST and MOSFIRE, for a simulated protocluster at z = 2.2. Blue and gold circles indicate *ISCEA* wide and deep fields respectively.

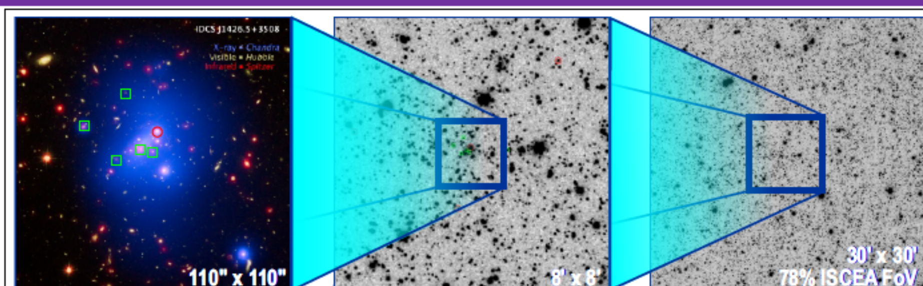
ISCEA Addresses NASA Priorities

- **Pushes the envelope for "Big Science" on a small budget**
- **Demonstrates the key instrument technology of Digital Micro-mirror Device (DMD)**
- **Delivers game changing science of cosmic evolution**
- **Legacy dataset that will be data mined for future studies of galaxies evolution**

Mission Overview

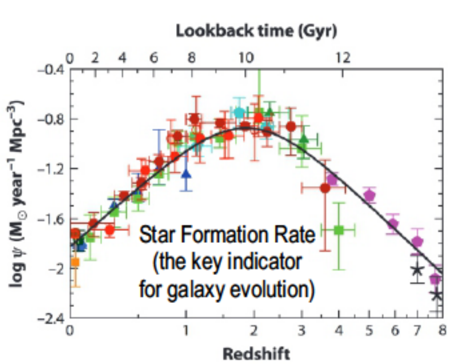


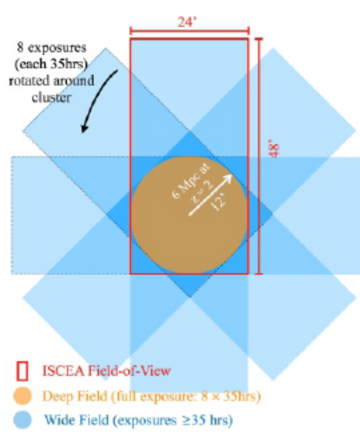
ISCEA provides NIR spectroscopy and imaging data of galaxies (red) to trace the cosmic web of dark matter (grayscale) @ 1.6 < z < 2.4

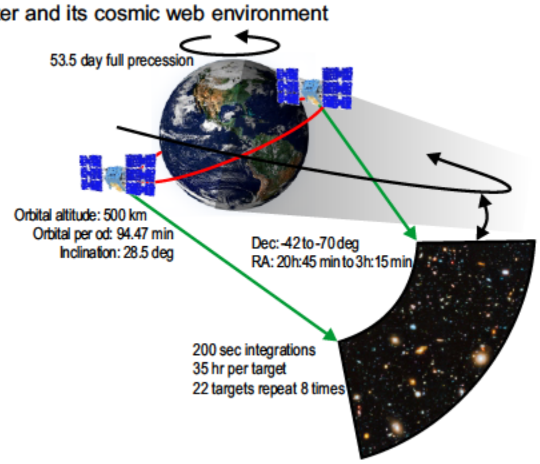


ISCEA increases the scale and resolution of 3D galaxy maps of clusters by > 10x current observations.

- *ISCEA* is an ESPA class SmallSat mission with a 25cm aperture 0.32 deg^2 FOV telescope, and multi object 0.9 to1.7 μm NIR Spectroscopy and Imaging Instrument
- *ISCEA* uses a DMD to simultaneously obtain R=1000 slit spectra for 500 galaxies in each of 22 fields
- Each *ISCEA* target field contains a massive cluster and its cosmic web environment







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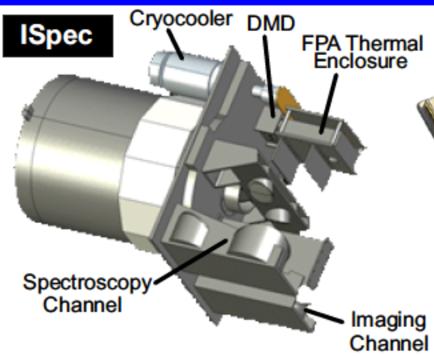
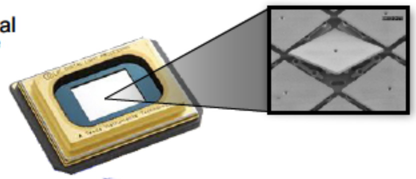
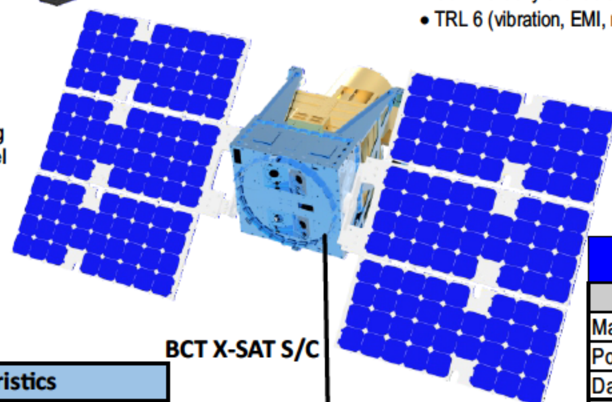
ISCEA NIR dual-channel Spectroscopic and Imaging Observatory

ISpec





- DMD 1024 x 768 element micro electrical mechanical system (MEMS) micro mirror array
- Individual micro mirrors commandable to create two separate optical paths
- Each micro mirror can be selected to route light to Spectroscopy channel or to the Imaging channel
- Commercially available, highly reliable, millions of DMDs in use
- TRL 6 (vibration, EMI, radiation)

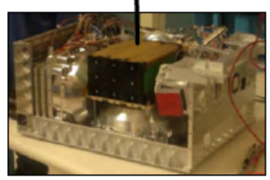


- 25cm Aperture
- Simultaneous Spectroscopy and Imaging Channels
- "Pixel" Commandable DMD Target Control
- H2RG detector & SIDECAR FPAs
- SwRI Instrument Controller
- Cryocooler maintains FPA @ 140K

Margins

TRM	Required	Available	Margin
Mass	104.5 kg	175.0 kg	67%
Power	154.9 W	255 W	65%
Data Downlink	0.9 GB	1.4 GB	57%
Downlink	14.8 dB	3 dB	11.77 dB
Fine Pointing (3 sigma)	3.97"	1.8"	120%

ISCEA Spacecraft	Characteristics
Spacecraft Provider	Blue Canyon Technologies
Mass	104.6 kg
Power Consumption	154.9 W (Cold Case)
Solar Arrays	Dual 3 panel deployable, single axis gimbal
	28.4% Cell Efficiency EOL
	255 W EOL Orbit Average Power
Battery	10.2 Ahr Capacity
	8p3s Cell Type
Attitude Performance	1.8"/200s (3sigma)
Primary Attitude Sensor	Star Trackers x2
Primary Control Actuator	Reaction Wheels x4
Thermal Control	Heaters, MLI, OSR Radiator, Cryocooler
Communication	S Band Uplink, 125 kbps
	S Band Downlink, 256 kbps
	X Band Downlink, 17 Mbps



- Simple, low risk mission design
- Innovative approach
- Proven commercial technology
- Breakthrough instrument performance
- Heritage TRL-8 high performance S/C
- Robust margins in all areas
- Well-defined AI&T approach
- Simple operational concept

ISCEA Project Summary

ISCEA Team Structure

Small Experienced Team

- NASA Explorers Program Office
- Principal Investigator: Yun Wang
  - Senior Advisory Board
  - Science Team
- Project Manager: Pete Roming
  - Project System Engineer: Randy Rose
  - Safety & Mission Assurance: Joerg Gerhardus
  - ISpec: Mike Davis
  - Spacecraft: BCT
  - Observatory AI&T: Martin Wasiewicz
  - Launch Vehicle: Randy Rose
  - Science Operations: Lee Armus
  - Mission Operations: Debi Rose

Key
- Caltech/IPAC
- SwRI
- BCT

Big Science on a Small Budget

FY2020	FY2021	FY2022	FY2023	FY2024	FY2025
CY2020	CY2021	CY2022	CY2023	CY2024	CY2025

Apr Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct

Phase A | Phase B | Phase C | Phase D | Phase E | φF

SRR PDR CDR SIR PER PSR LRR PIR DR DRR

ORR MRR Launch

PLAR

Caltech ipac SwRI Blue Canyon Technologies

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