

UVEX



The Ultraviolet Explorer

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UVEX Science

The Low-Mass, Low-Metallicity Galaxy Frontier

UVEX will uncover the lowest mass, most pristine local galaxies and diagnose their unique cosmic ecosystems
2020 Decadal priority area: Drivers of Galaxy Growth

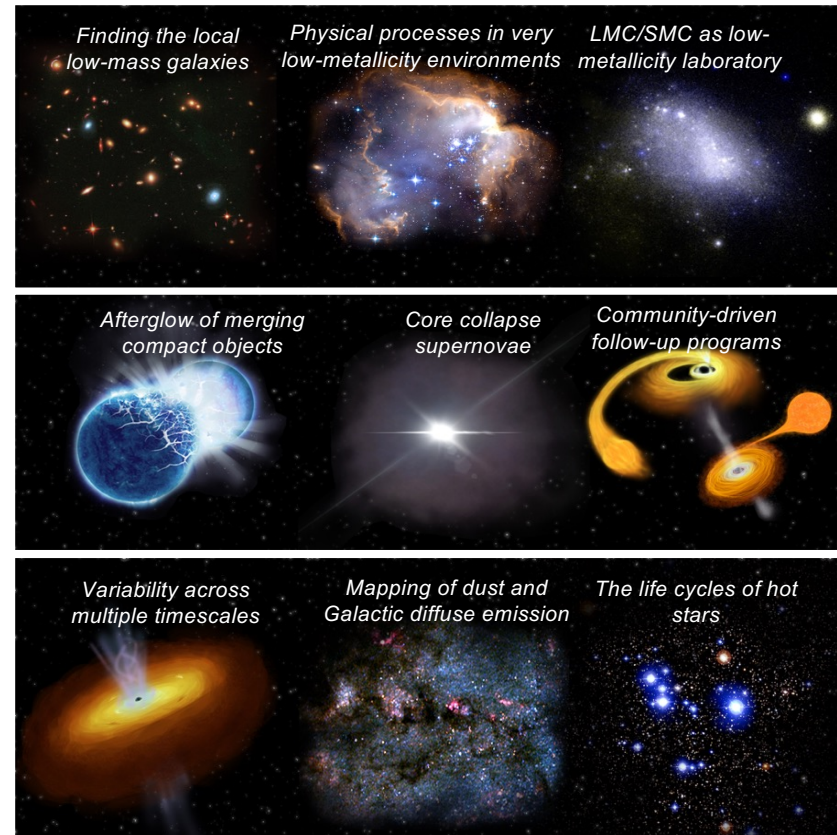
New Views of the Dynamic Universe

UVEX will follow-up multi-messenger and community triggers to probe the early UV emission of transients
2020 Decadal priority area: New Windows on the Dynamic Universe

A Legacy of Deep, Synoptic All-Sky Surveys

UVEX cadenced all-sky imaging leaves a legacy dataset for the entire community.

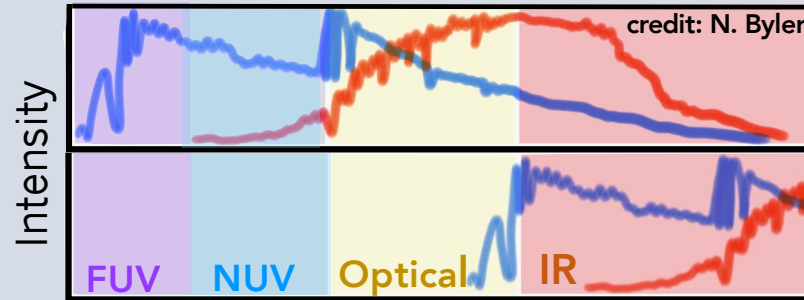
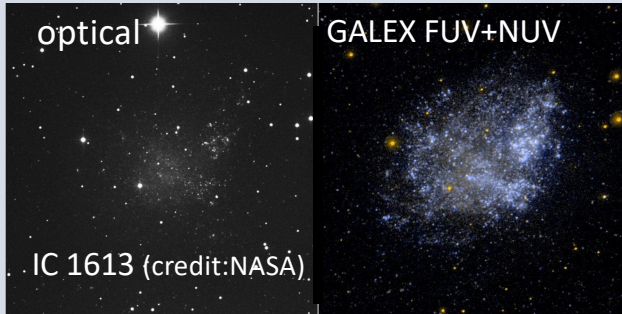
2020 Decadal priority areas: Drivers of Galaxy Growth, New Windows on the Dynamic Universe



Why UV?

Drivers of galaxy growth

Rest-frame UV spectra characterize galaxy evolution across redshift

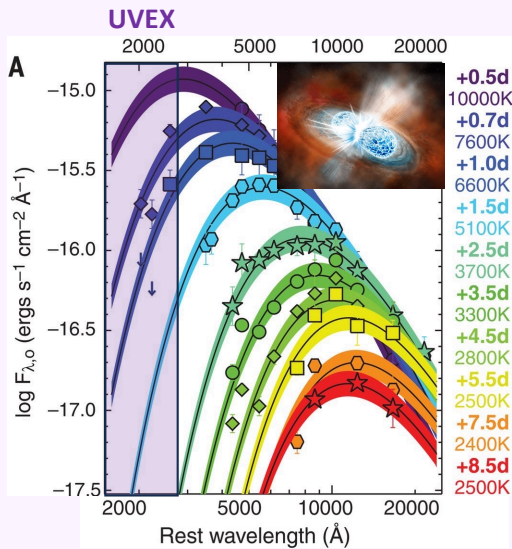


Z~0.1 - UVEX
(local universe)

Z>6 - JWST
(distant universe)

UV dominates in galaxies actively forming stars

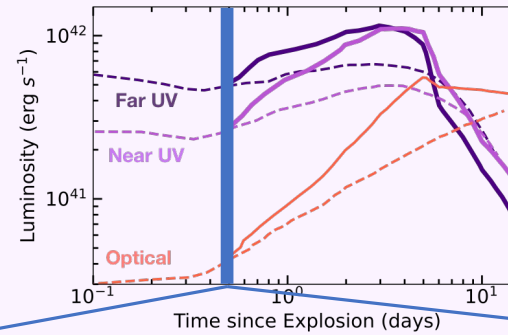
Wavelength



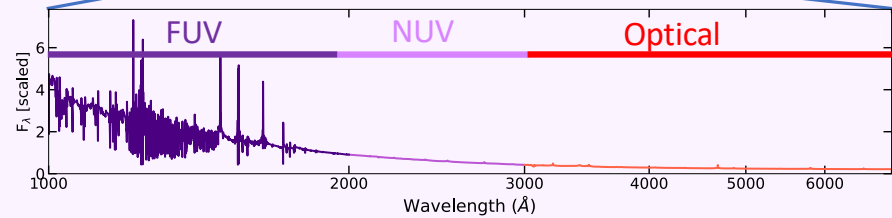
Dynamic Universe

GW-discovered
neutron star mergers
emit first in UV light

Key diagnostic
lines lie in UV



Massive star
explosions evolve
UV-optical



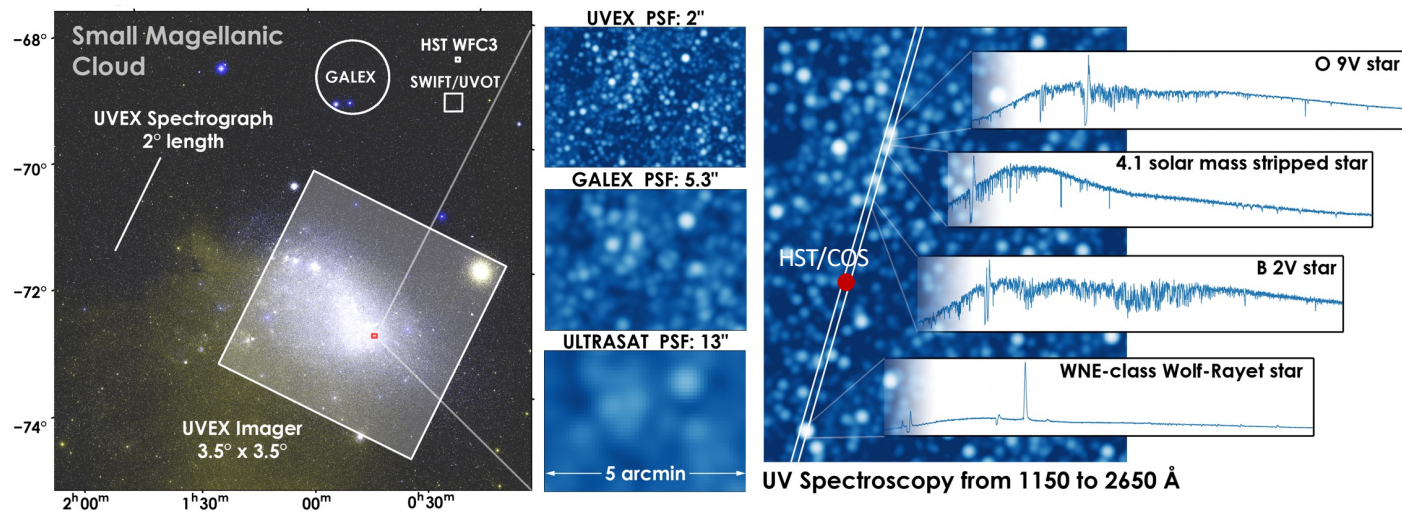
UVEX Capabilities

UVEX provides three crucial capabilities

Sensitive wide-field imaging in two ultraviolet bands (NUV & FUV)

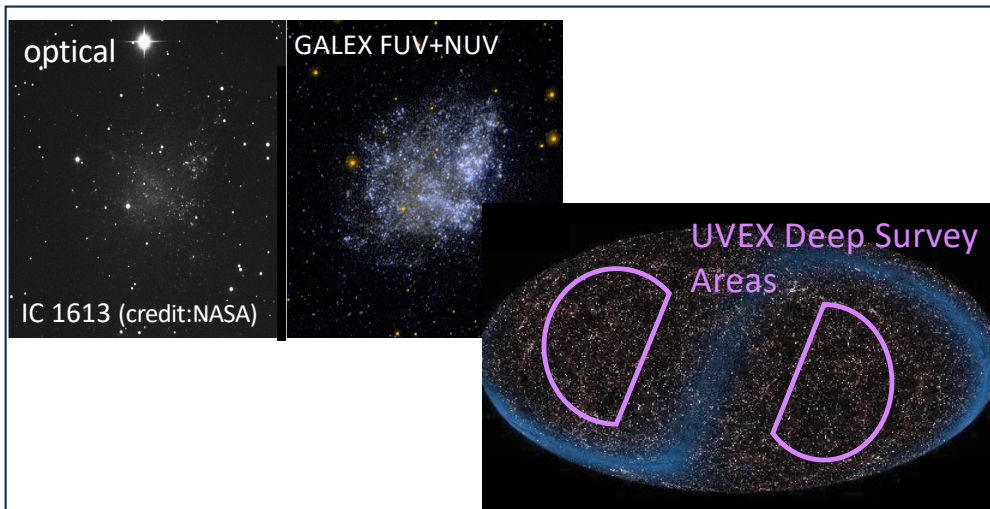
High angular resolution across large field of view (2.25 "/math>10 \text{ deg}^2</math>)

Broadband ultraviolet spectroscopy (1150 – 2650 Å)



Low-Mass Galaxy Frontier - Science Objective 1

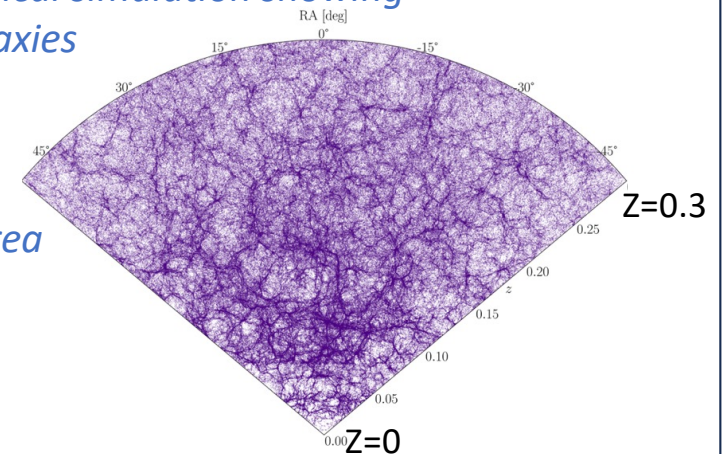
Find the local ($z \sim 0.1-0.3$) low mass star forming galaxies through wide-field imaging surveys and associate them with cosmic structures



Large-area survey of the extragalactic sky $\sim 100\times$ deeper than existing GALEX data in NUV and FUV

Cosmological simulation showing UVEX galaxies

1.5% of UVEX survey area

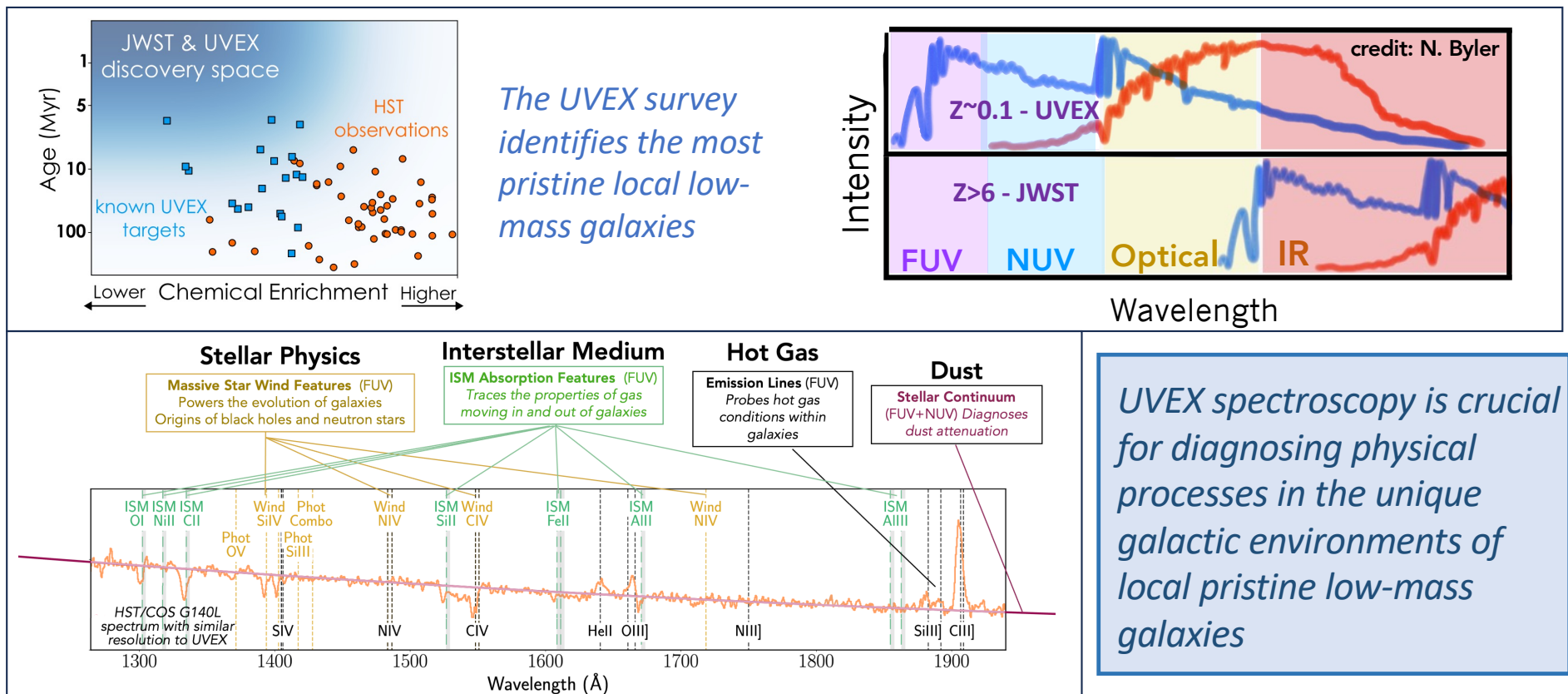


UVEX will identify $15 - 200 \times 10^6$ low-mass local galaxies. To date $< 1\%$ of these have been identified anywhere on the sky

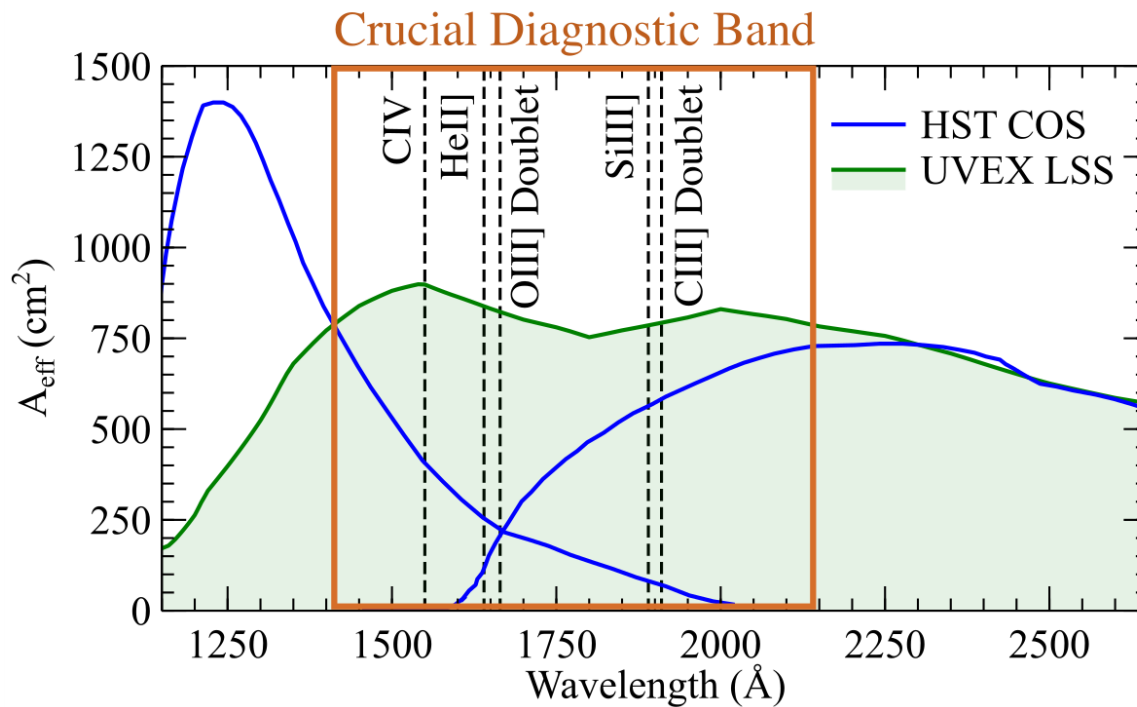
Very deep UVEX FUV and NUV imaging is essential for identifying the largely uncharted local low-mass galaxy population

Low-Mass Galaxy Frontier - Science Objective 2

Diagnose the physical processes occurring in their unique environments through spectroscopy of galaxies selected from the extragalactic survey



UVEX Spectroscopy



UVEX designed for sensitivity across crucial UV band

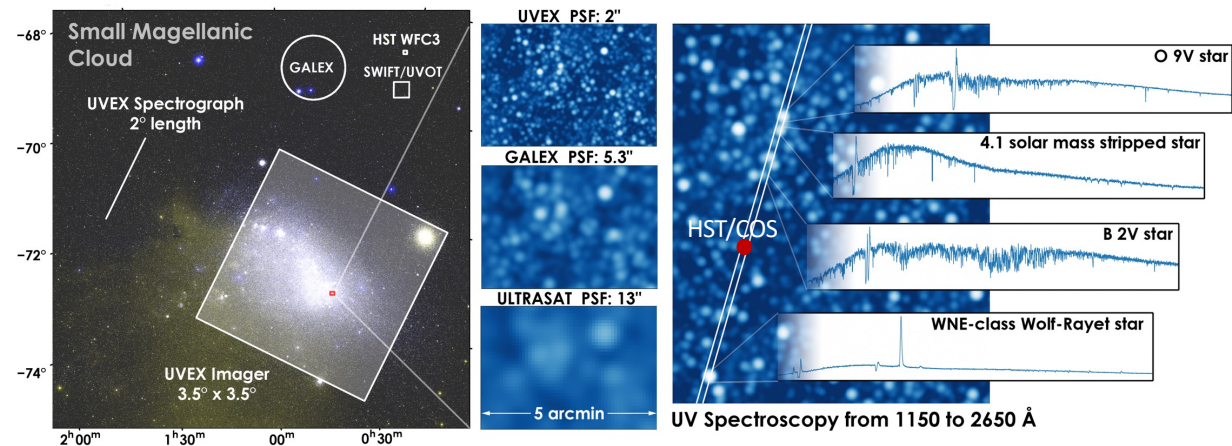
Galaxy Frontier Science - Objective 3

Determine the evolution of hot single and binary stars in the Magellanic clouds

The Magellanic clouds are unique laboratories for understanding stellar evolution



The Small Magellanic cloud

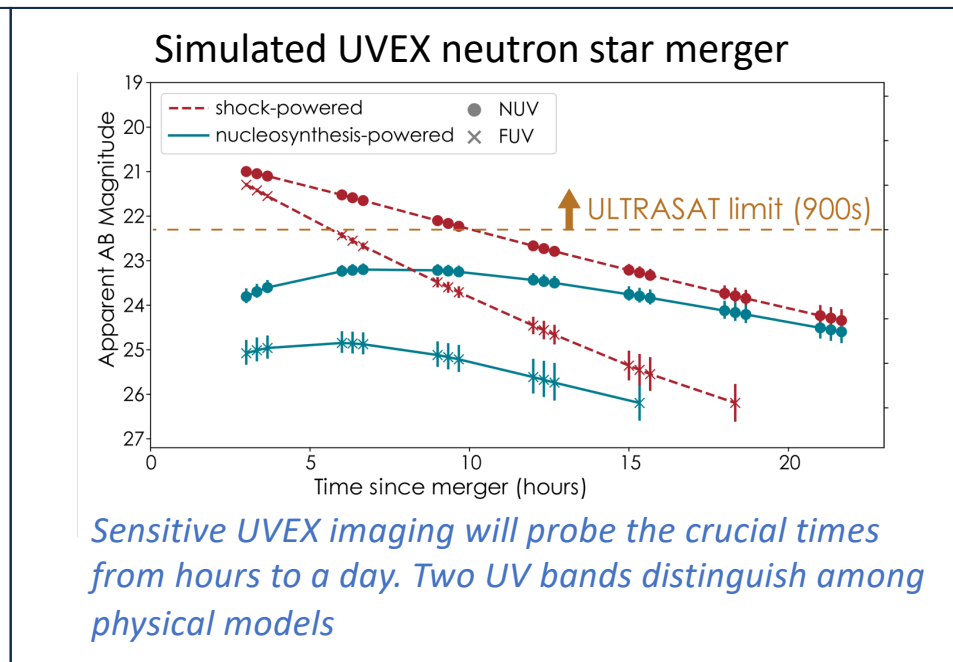
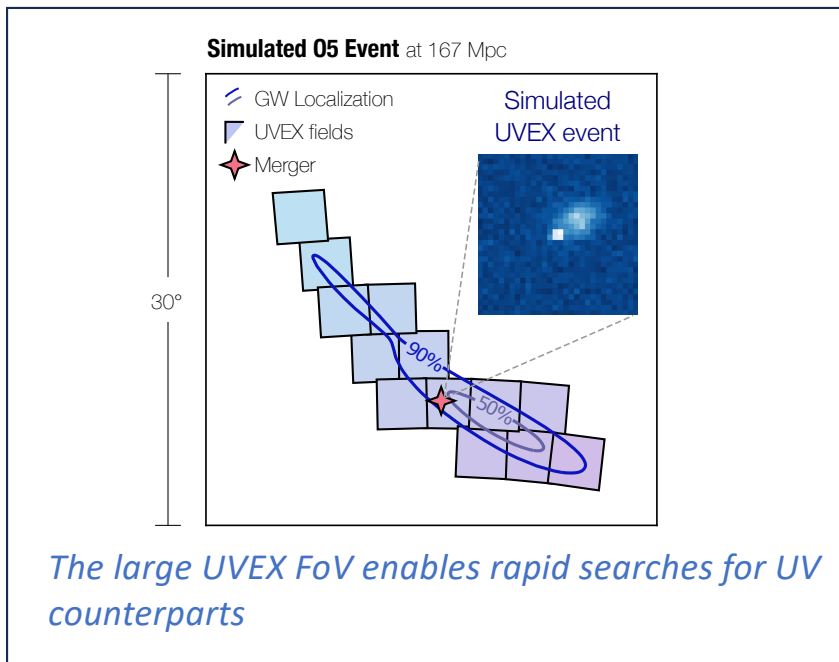


UVEX sensitive time series imaging identifies hot stars, rare binaries and eclipsing. The large UVEX spectroscopic sample provides the definitive data for understanding stellar mass loss, a key driver of galaxy evolution

UVEX will provide the definitive surveys for determining the mass-loss driven evolution of hot stars, key for understanding how galaxies evolve

Dynamic Universe - Objective 1

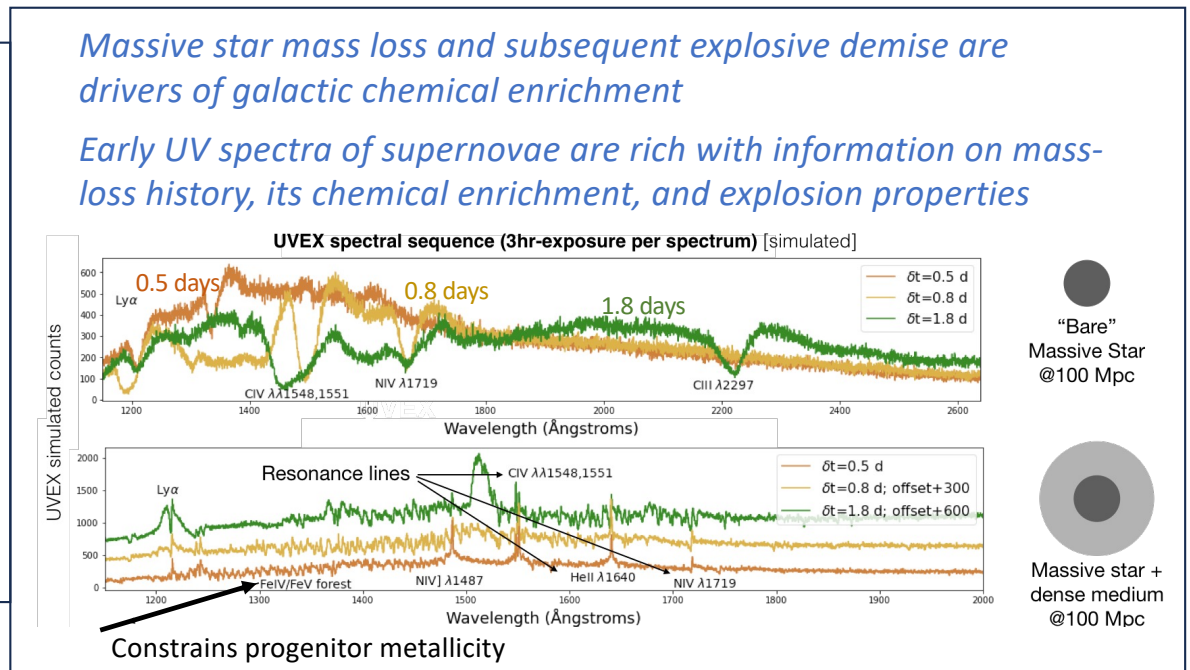
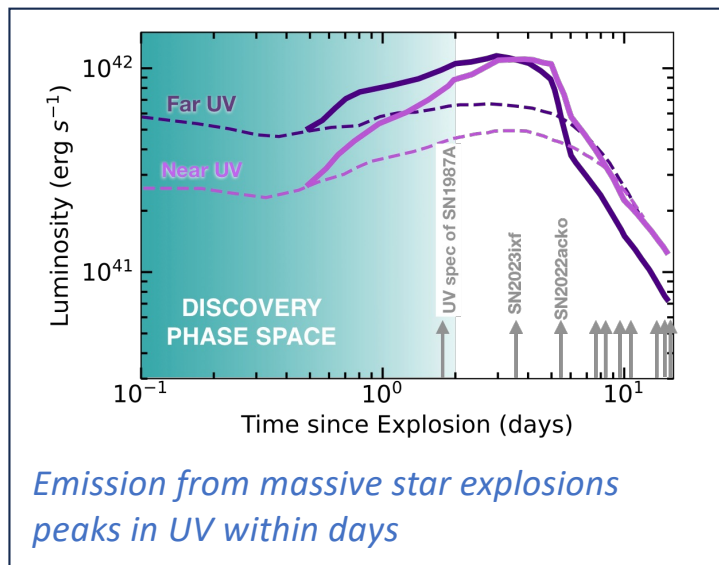
Perform rapid follow-up of gravitational wave events discovered by the LIGO/Virgo gravitational wave observatories from hours to days post-merger



With a large field of view and two imaging bands UVEX is ideally suited for identifying counterparts to gravitational wave events and probing their fundamental physics

Dynamic Universe - Objective 2

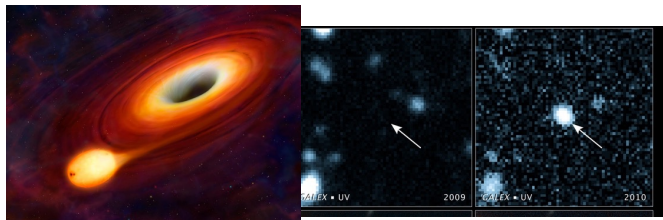
Measure pre-explosion mass loss and supernova properties through rapid spectroscopic observations of supernovae to understand their role in galactic enrichment



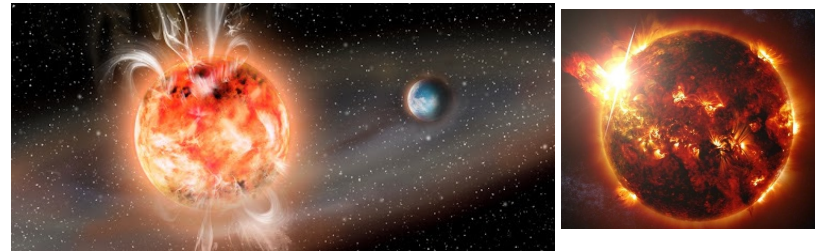
With unprecedented early UV spectroscopy UVEX provides a new window on supernova-driven galactic chemical enrichment

Dynamic Universe - Objective 3

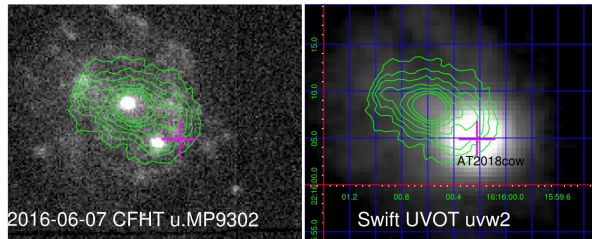
Provide a resource for the community to explore the dynamic sky through rapid UV spectroscopic follow-up



Broad absorption lines in stars being eaten by supermassive black holes



Energetic flares on active stars



Relativistic supernovae - UV-bright fast blue optical transients



Accretion physics at the end of the stellar lifecycle – novae, low-mass X-ray binaries

By providing the first rapid spectroscopic UV follow-up capability UVEX enables a broad range of time-domain science and opens tremendous discovery space

Deep Synoptic Surveys – Objective 1

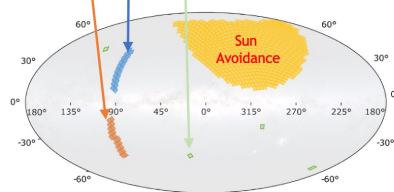
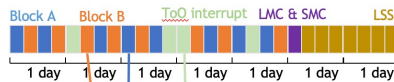
Explore the UV time domain sky by performing imaging surveys of the sky in two UV bands with cadences spanning hours to months



UVEX will discover variable and transient UV phenomena and alert the community for follow-up

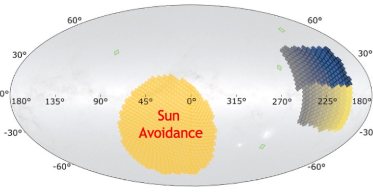
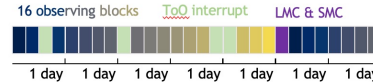
High Cadence Survey

2 blocks at ~12-hr cadence, including interrupts, ~5 days total



Low Cadence Survey

16 blocks at ~4-day cadence, including interrupts, ~32 days total

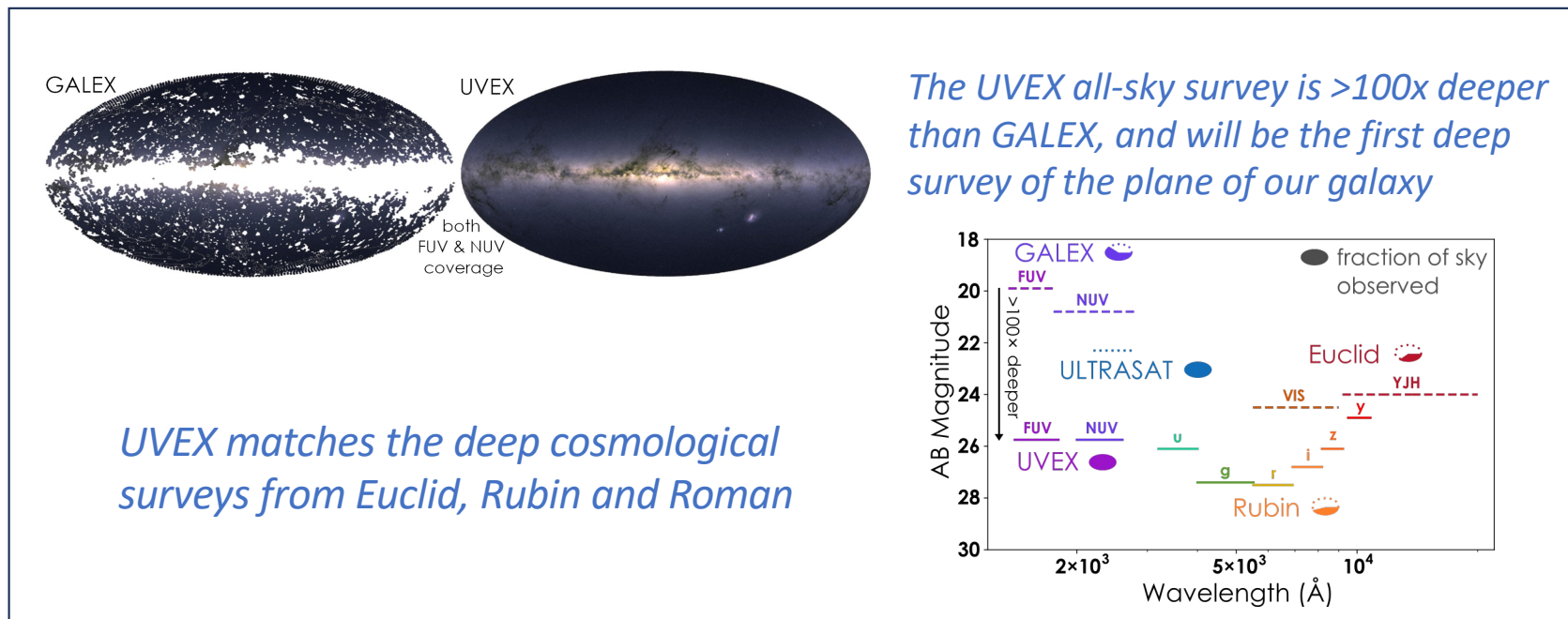


A variety of cadences will probe fast transients, tidal disruption events and monitor variability

UVEX provides a modern UV time-domain survey

Deep Synoptic Surveys – Objective 2

Provide deep all-sky maps in two UV bands with sensitivity and resolution complementing modern wide-field surveys in the optical and infrared

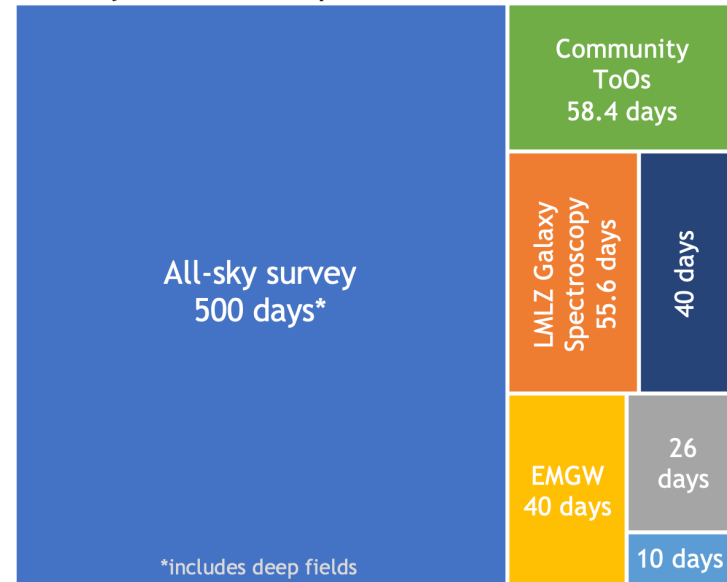


UVEX covers the entire sky, and achieves depth and resolution matching modern optical and IR facilities

Observing Plan

All-sky survey completes in ~500 days
Average of 10 visits per survey tile over two years
ToO observations, spectroscopic surveys completed between sky survey blocks

730 days of science operations



*includes deep fields

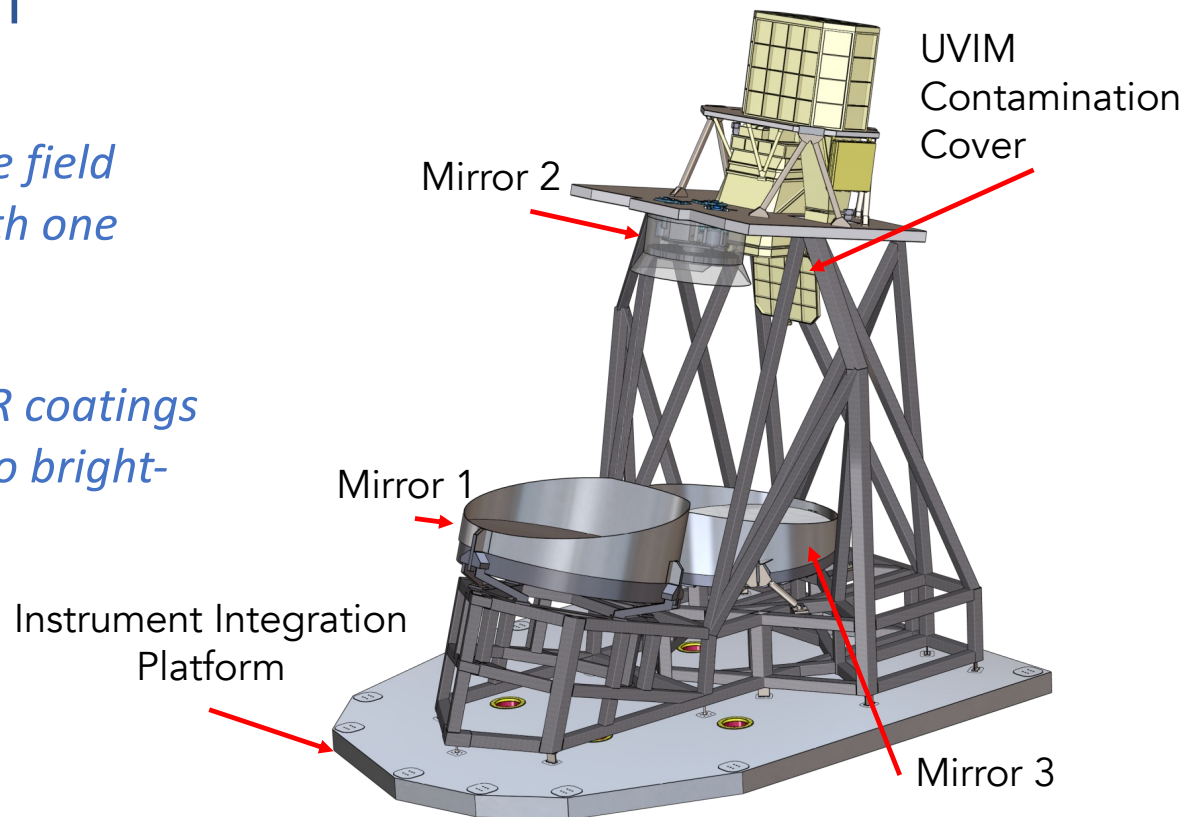
Calibration & Reserve
LMC/SMC (imaging & spectroscopy)
Rapid CC SNe spectroscopy

All science objectives are met in two years with reserve

Instrument Design

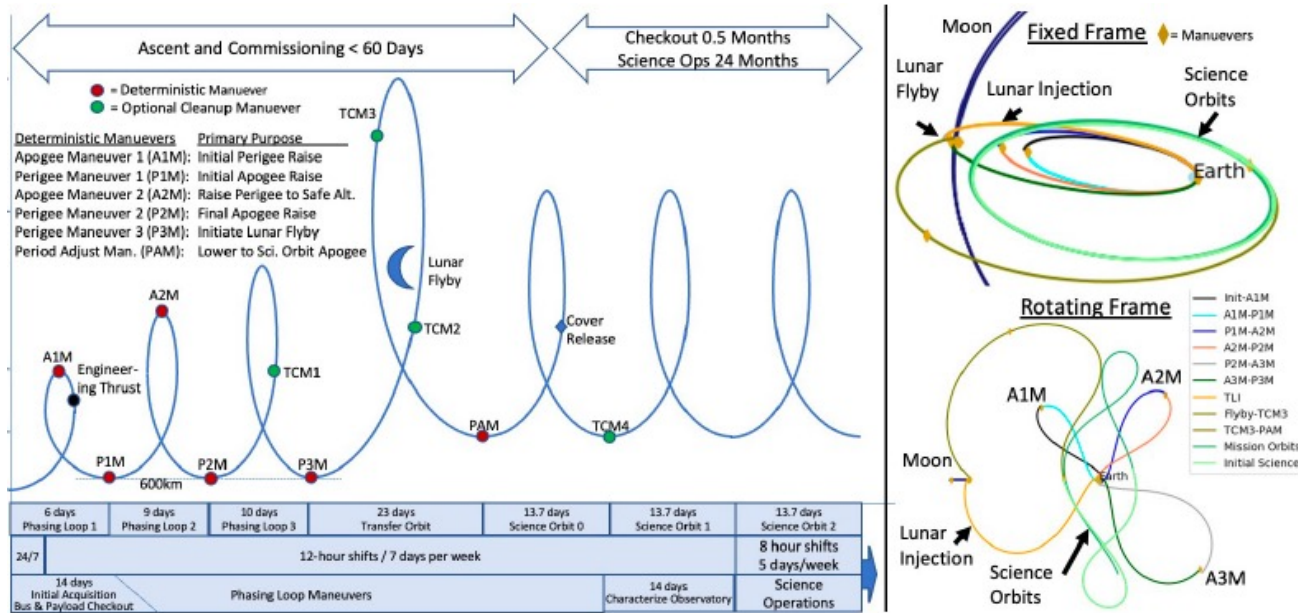
Telescope design enables wide field imaging and spectroscopy with one instrument

CMOS sensors with custom AR coatings provide high efficiency with no bright-object constraints



A single instrument module, heritage structure, and a simple interface to the spacecraft reduces overall implementation risk

Science Orbit



A Lunar-resonant TESS-like orbit provides eliminates atmospheric airglow and provides high observing efficiency and a naturally benign thermal environment

Employing the highly-elliptical orbit pioneered by TESS reduces background and simplifies thermal engineering

Mission Implementation Overview

Caltech is the PI institution providing the focal plane, science operations, science data center

UC Berkeley will implement the project for Caltech and provide the telescope and mission operations

Northrop Grumman provides the spacecraft and observatory I&T and Launch

IPAC/IRSA provide data pipeline and archive

UVEX Science Leadership Team



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PI



Brian Grefenstette, Caltech
Project Scientist



Shri Kulkarni, Caltech
Science Team Lead



Hannah Earnshaw, Caltech
Science Team Coordinator



Dan Weisz, UC Berkeley
Low Mass Galaxy Frontier Lead



Suvi Gezari, STScI
Dynamic Universe Lead



Keivan Stassun, Vanderbilt
Legacy Survey Lead



Danielle Berg, UT Austin
galaxy spectroscopy lead



Hugues Sana, Leuven
LMC/SMC lead



Mansi Kasliwal, Caltech
EMGW lead



Rafaella Margutti, UCB
CCSNe Lead



Matthew Graham,
Caltech Synoptic
Survey lead



Harry Teplitz, IPAC,
Imaging survey lead

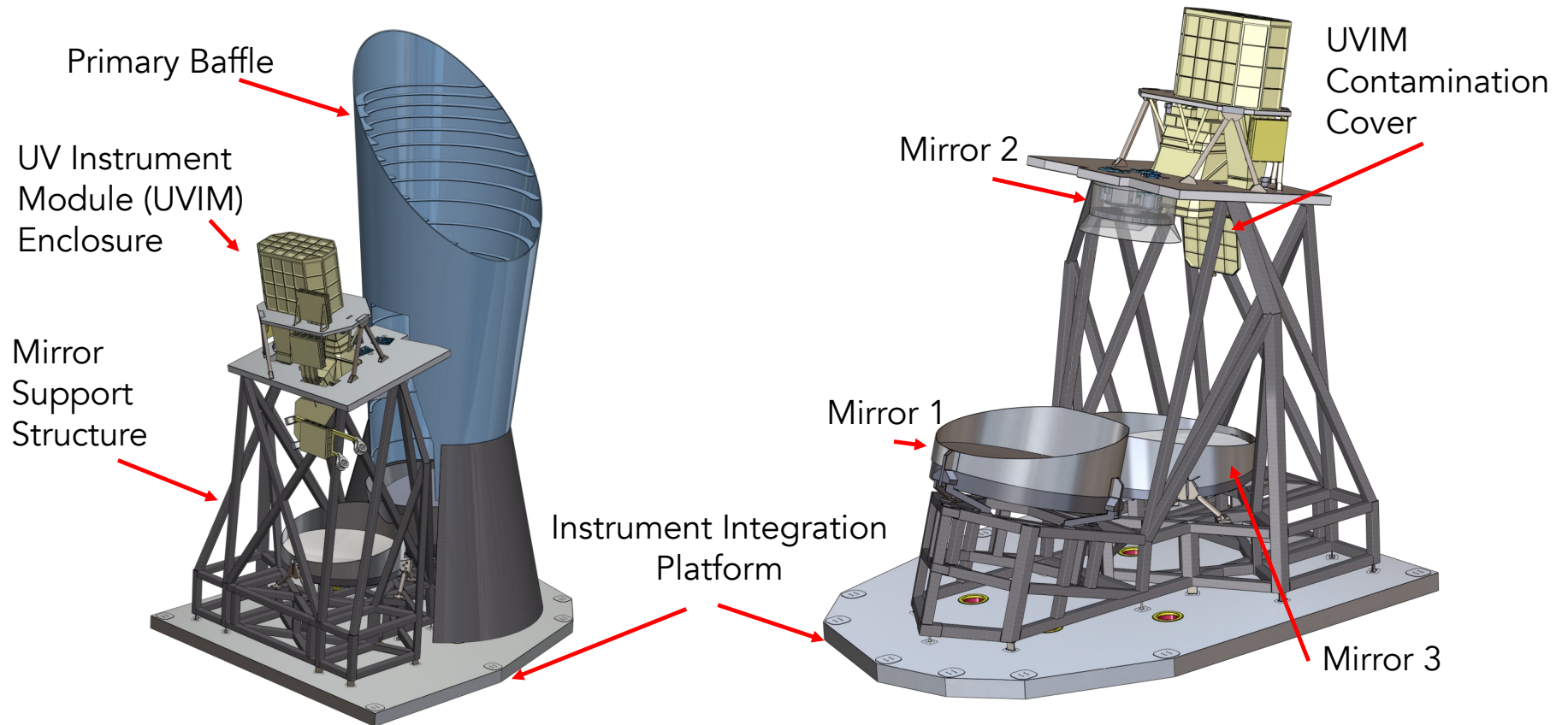
See <https://www.uvex.caltech.edu/> for full science team

Summary

- UVEX's combination of capabilities will answer fundamental scientific questions and address Astro2020 priority science
- The UVEX implementation is based on mature technologies and established processes with well-understood residual risks
- The broad UVEX science team is well-positioned to deliver science return, and the implementation team has deep and successful experience with Explorer mission development
- UVEX amplifies NASA's investments in JWST, Euclid and Roman, and fills important gaps in capability not addressed by any current or planned mission

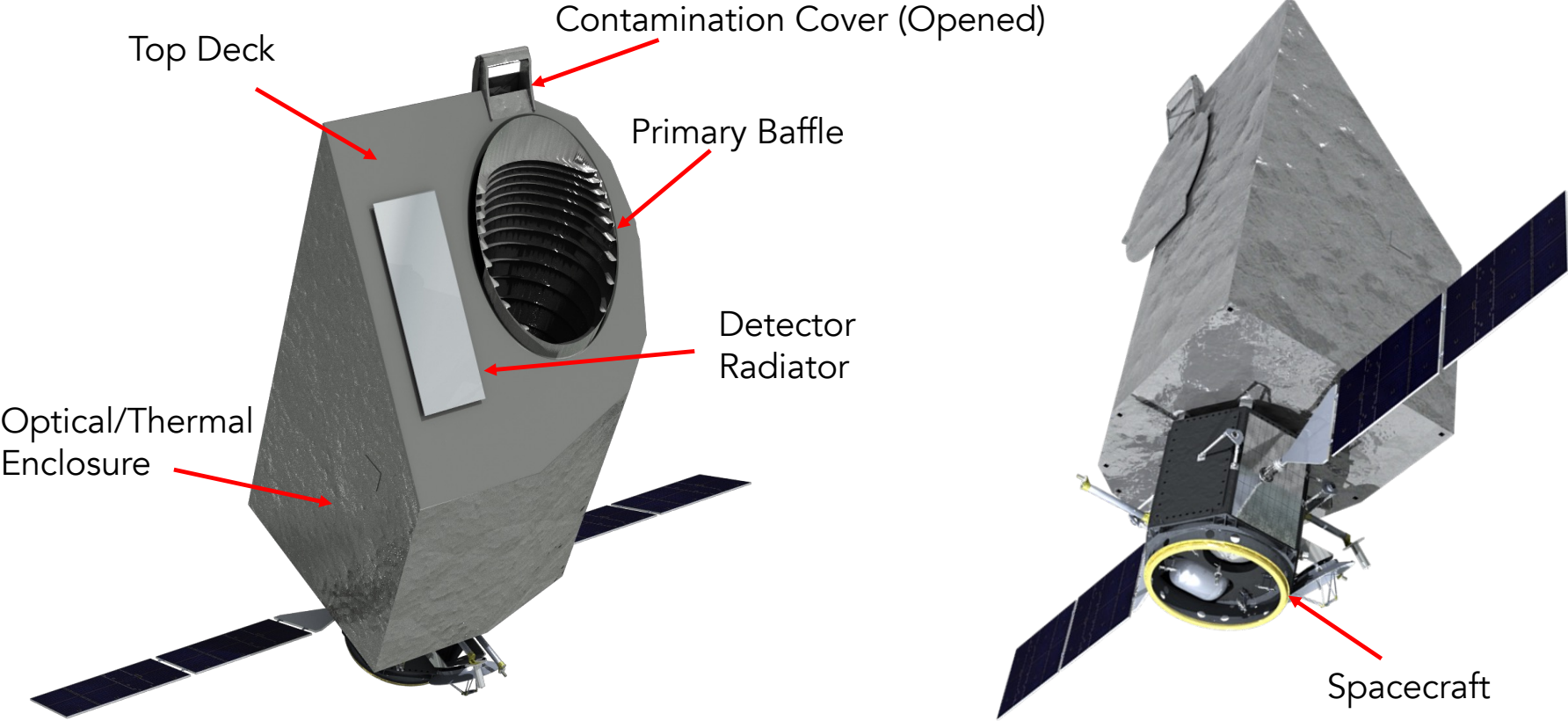
Backup Slides

Instrument Design



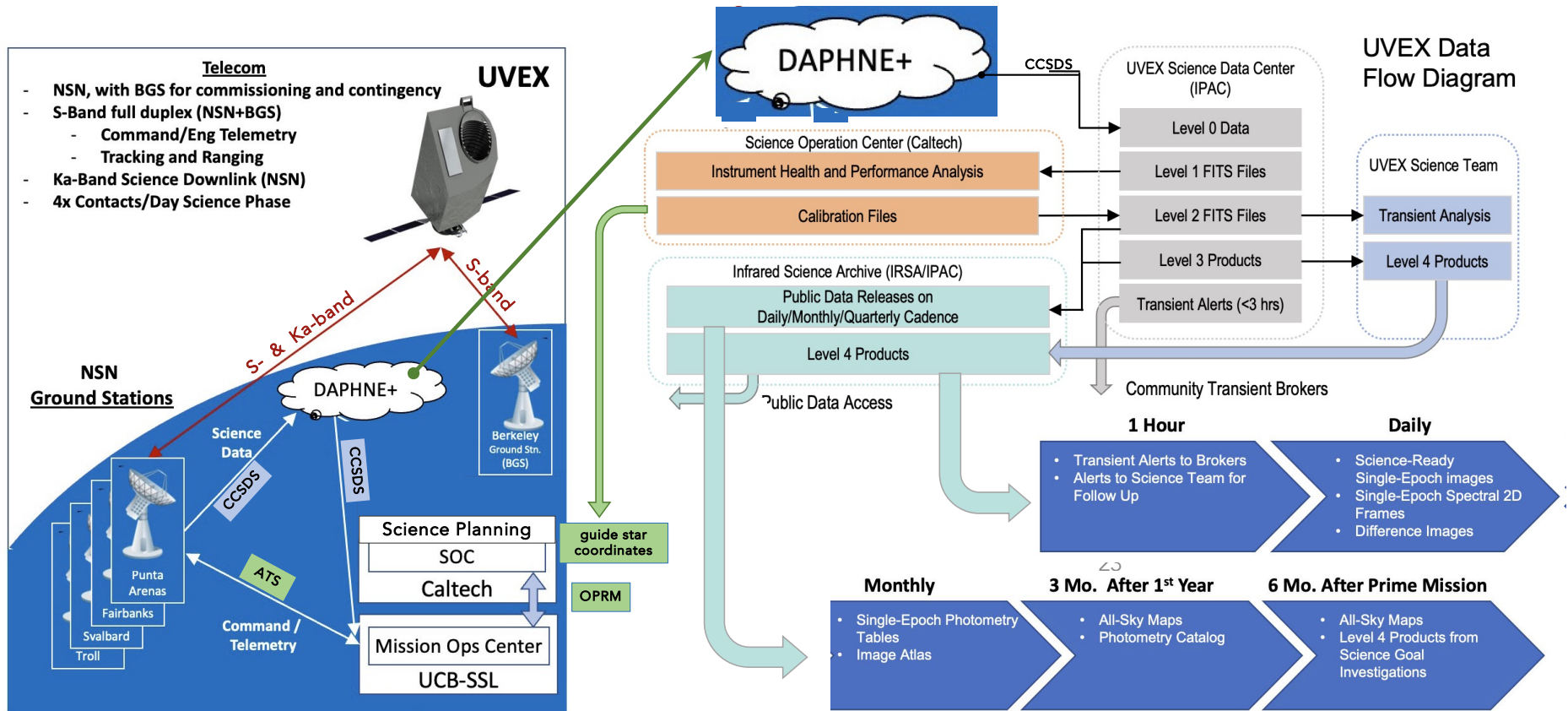
A single instrument module, heritage structure, and a simple interface to the spacecraft reduces overall implementation risk

Observatory Design



The integrated structural/optical/thermal design enables both survey and fast follow-up capabilities

Communications and Ground Data Systems



Mission Operations at Berkeley and Science Operations at Caltech are performed by the same teams that have operated NuSTAR for over a decade