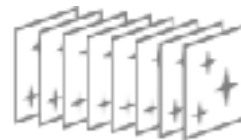
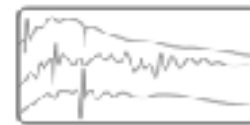




All-Sky



Time Domain



Spectroscopy

The Ultraviolet Explorer (UVEX) Mission

Anne Verhamme

University of Geneva

UVEX collaboration

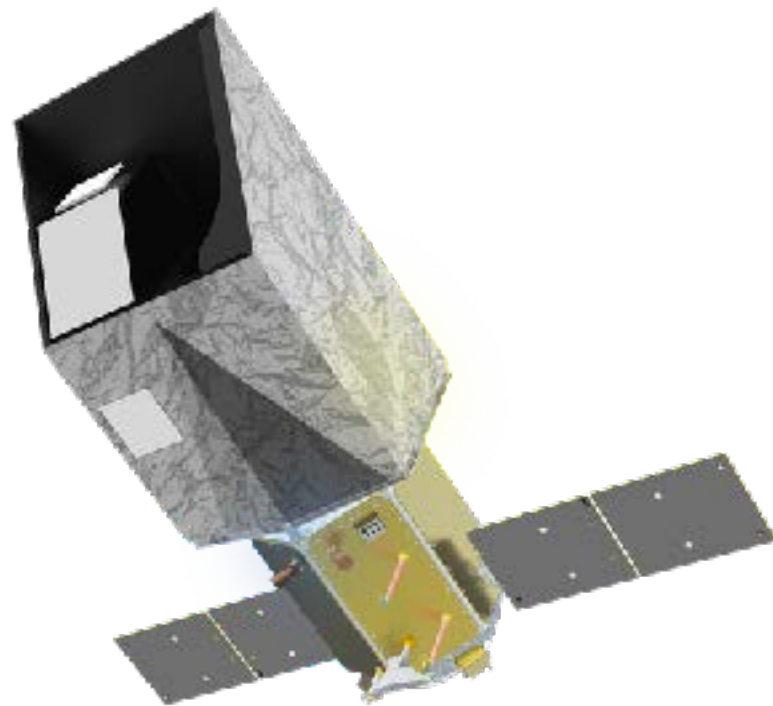
October 8, 2026



UVEX Concept paper: Kulkarni+ (2021)
UVEX Mission paper: Harrison+ (submitted)

UVEX at a Glance

- **NASA Medium-Class Explorer (MIDEX).** Selected 2024, launch in 2030
- **Two-year baseline science mission** run by the Science Team; all data public immediately
- **Cadenced, All-sky imaging** in FUV + NUV, ~50-100× deeper than GALEX, including the Galactic Plane
- **Long-slit UV spectroscopy** 1150–2800 Å at $R \approx 2000$ –4600, with HST/COS-like sensitivity
- **Rapid response:** on target < 6 hr after a trigger; 8% of time reserved for community ToOs



UVEX observatory: 75 cm three-mirror telescope feeding two imagers and a spectrograph.

Who Builds and Operates UVEX

Caltech

Caltech

PI institution: focal plane, science operations, Science Data Center

Berkeley

UC Berkeley / SSL

Project implementation, telescope, mission operations

NORTHROP GRUMMAN

Northrop Grumman

Spacecraft, observatory integration & test, launch

ipac

IPAC / IRSA

Data pipeline and the public archive

Leadership

Principal Investigator

Fiona Harrison (Caltech)

Project Scientist

Dan Weisz (UC Berkeley)

Science leadership

Low-mass galaxies: Dan Weisz (UC Berkeley)

Dynamic universe: Suvi Gezari (Maryland)

Survey legacy: Keivan Stassun (Vanderbilt)

Nebular emission: Danielle Berg (UT Austin)

Magellanic Clouds: Hugues Sana (KU Leuven)

Gravitational waves: Mansi Kasliwal (Caltech)

Supernovae: Raffaella Margutti (UC Berkeley)

UV time domain: Matthew Graham (Caltech)

Science team: ~90 scientists at ~40 institutions, including



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UNIVERSITY

TEXAS
The University of Texas at Austin

KU LEUVEN



UNIVERSITÉ
DE GENÈVE

UNIVERSITY OF ARIZONA



MIT

JPL
Jet Propulsion Laboratory
California Institute of Technology



TEL AVIV
UNIVERSITY

LIÈGE
université

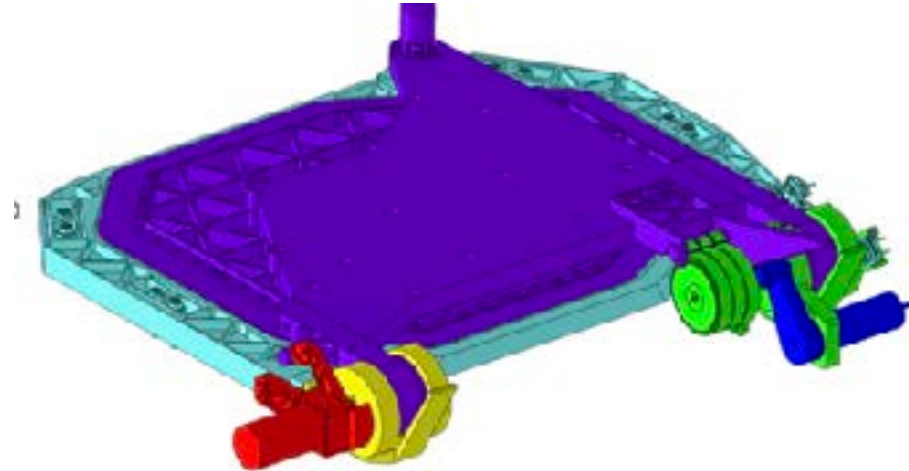
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University of Colorado
Boulder

Swiss contribution to UVEX

- **The UVIM door:** re-closable door to protect the detector and calibrations
- **Science case:** Predictions for characterising the population of Lyman continuum emitters at intermediate redshifts
- **UVEX center of expertise:** mentor and train european astronomers to use UVEX data



The UVIM door preliminary design



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DE GENÈVE

University of Amsterdam



JPL
Jet Propulsion Laboratory
California Institute of Technology



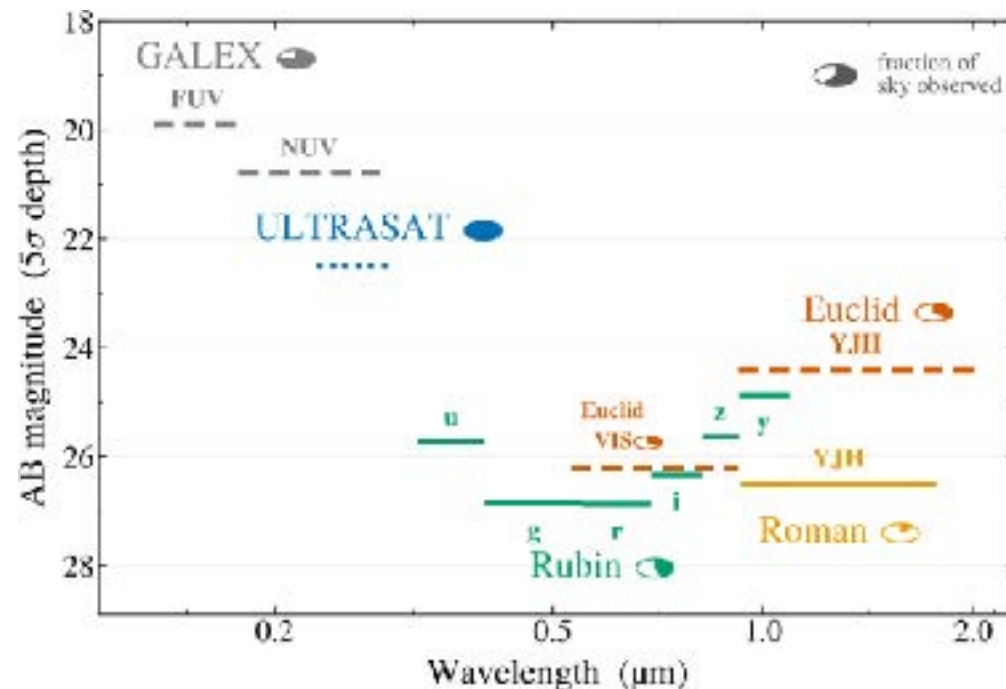
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The 2030s Survey Landscape

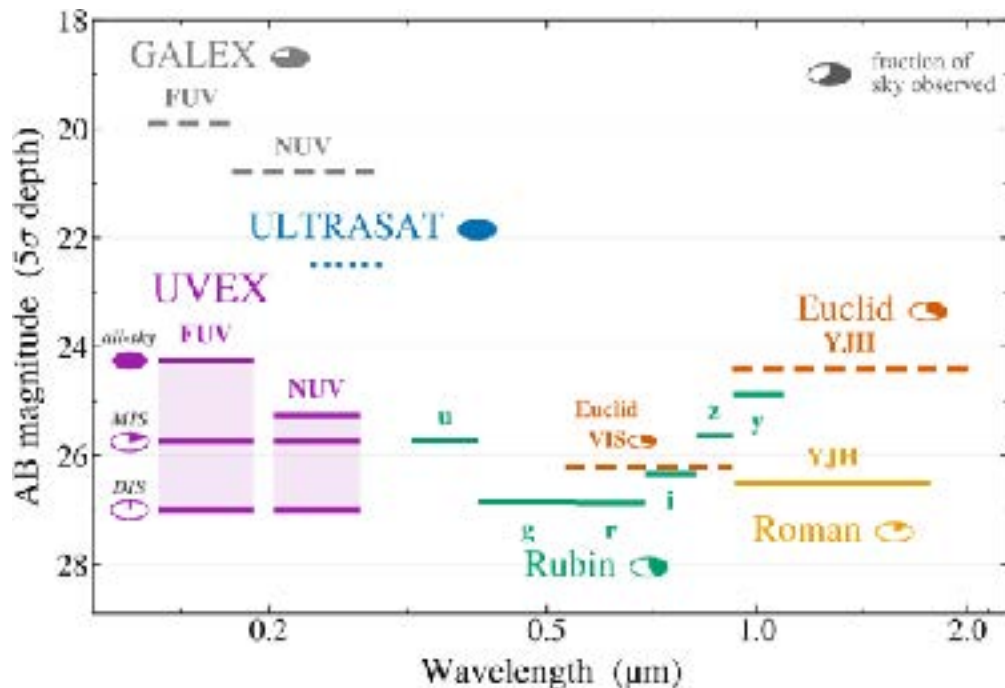
- **Optical and infrared:** Rubin, Euclid and Roman will map the sky to 25–28 AB mag
- **Time domain and multi-messenger:** Rubin alerts, LIGO/Virgo/KAGRA O5, DSA-2000, ULTRASAT
- **JWST** continues to deliver rest-frame UV spectra of galaxies at $z > 6$, with few local UV comparison samples
- **Ultraviolet surveys:** GALEX's all-sky survey reaches only ~20 AB mag; ULTRASAT is NUV-only at ~22.5 AB mag; HST is deep but narrow, with limited ToO response time



5 σ survey depths of GALEX, ULTRASAT, Rubin, Euclid and Roman.

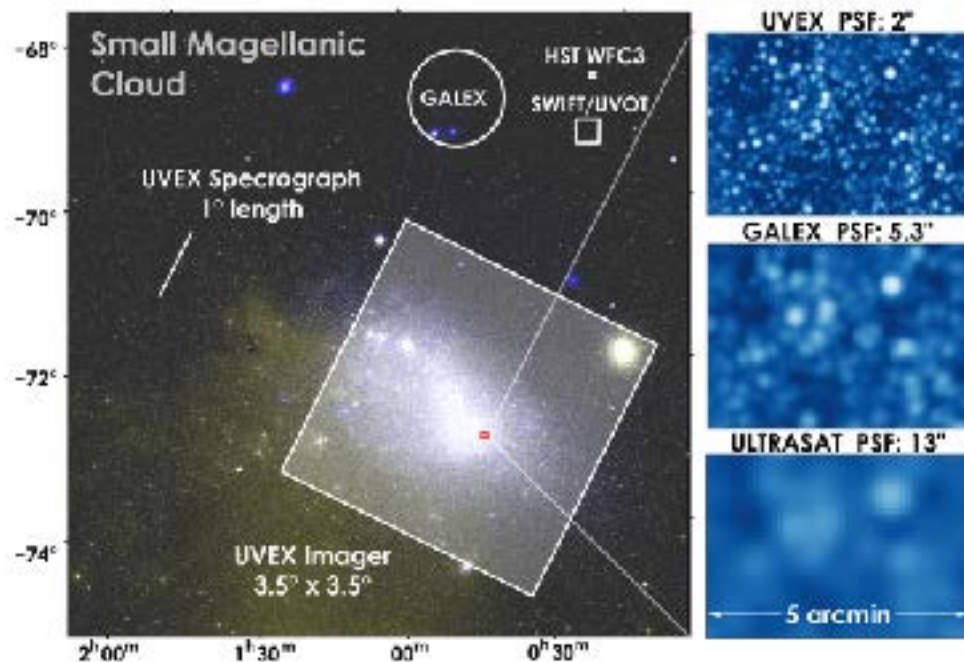
Why the UV, and Why Now: UVEX Fills the Gap

- **The UV uniquely traces:**
 - hot young stars → star formation rates, stellar evolution, binarity, dust
 - hot evolved stars: white dwarfs and stripped stars
 - the earliest (< 1 day) phases of supernovae, neutron-star mergers, other transients (e.g., tidal disruption)
- **UVEX:** three imaging tiers matched to Rubin, Euclid and Roman — all-sky to 24–25 AB, Medium to 25.75, Deep to 27 — ~100× deeper than GALEX with a 2× sharper PSF
- **Plus** HST/COS-like long-slit spectroscopy and rapid response to transients
- **With ULTRASAT and HST,** the UV side of the 2030s landscape and a bridge to the Habitable Worlds Observatory

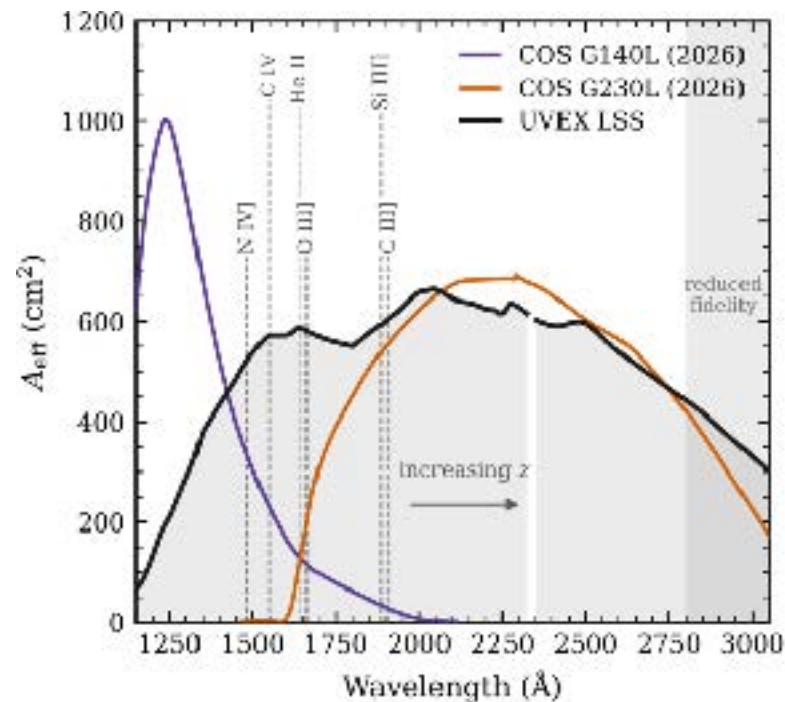


5σ depths of UVEX survey tiers (all-sky, Medium, Deep) vs. GALEX, ULTRASAT, Rubin, Euclid and Roman.

Wide-field Imaging and COS-like Spectroscopy



One 12 deg² pointing covers most of the SMC; the ~2" PSF resolves stars outside the densest clusters (compare GALEX 5.3", ULTRASAT 13").



Spectrograph effective area vs. HST/COS G140L and G230L (2026 sensitivities). UVEX covers the full range in one exposure and exceeds G140L by 2–20× over 1490–1900 Å.

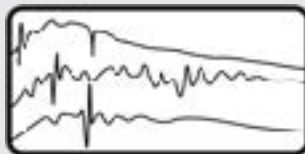
Three Science Goals for the Baseline Mission



The Low-Mass Galaxy Frontier

- Find and characterize local ($z \lesssim 0.3$) galaxies with $M_{\star} \sim 10^6\text{--}10^9 M_{\odot}$ over 8000 deg²
- Rest-UV spectra of the most metal-poor galaxies (C/O, nebular diagnostics)
- Stripped stars and massive-star winds in the Magellanic Clouds

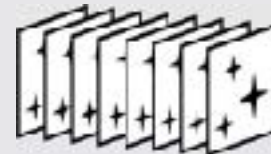
Goal 1



The Dynamic Universe

- Rapid UV tiling of LIGO O5 neutron-star merger sky maps
- First UV spectral sequences of supernovae at < 1 day
- 8% of time for a community-driven ToO & time-domain program

Goal 2



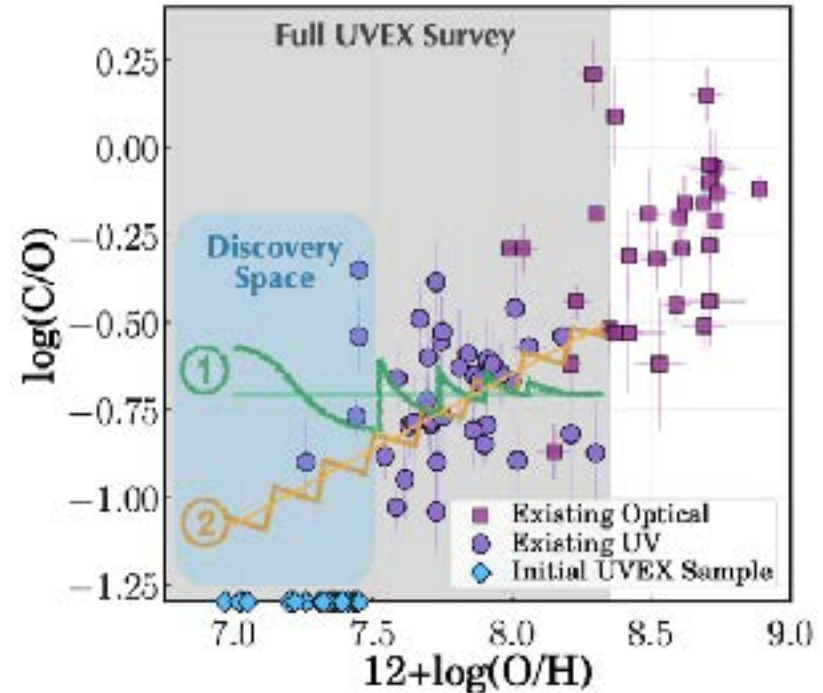
Deep Synoptic Surveys

- Cadenced FUV + NUV survey of the whole sky, over 100× deeper than GALEX
- 3–10 visits per field on cadences from days to months
- Public transient alerts; parallel spectra across the whole sky

Goal 3

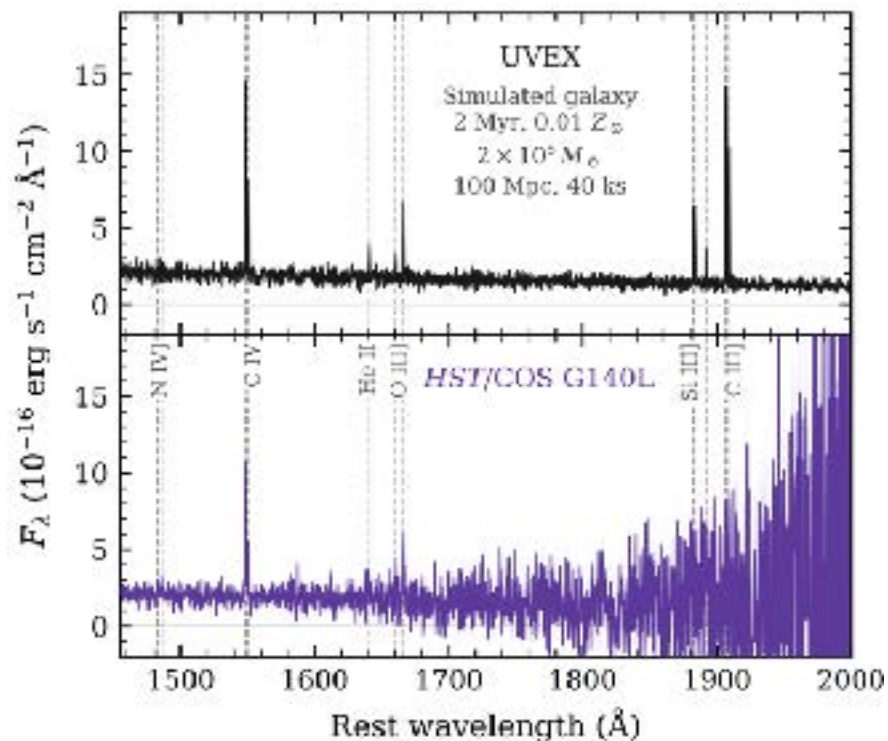
Goal 1: UV Spectroscopy of the Most Metal-poor Galaxies

- **UV spectra** have the same lines JWST sees at $z > 4$ — C IV, He II, O III], N IV], C III] — plus wind, photospheric and ISM absorption features
- **Goal:** C/O and nebular diagnostics for ≥ 25 star-forming LMLZ galaxies at $z \leq 0.47$, reaching extremely metal-poor ($\leq 5\% Z_{\odot}$) systems too faint for HST/COS
- **Why it matters:** Local calibrators for densities, temperatures and abundances inferred from high- z UV line ratios; templates for the first galaxies
- **Advantages over COS:** $2'' \times 1^{\circ}$ long slit captures extended emission; sensitivity extends to $2800 \text{ \AA}$, so C III] is measurable well beyond $z \sim 0.05$



C/O vs. metallicity: existing optical (squares) and UV (circles) measurements and the initial UVEX sample (diamonds). UVEX opens the low-metallicity regime where models diverge.

Goal 1: UVEX vs. HST/COS on the Same Metal-Poor Galaxy



Simulated 1% $Z_{\odot}$, $2 \times 10^5 M_{\odot}$ star-forming galaxy at 100 Mpc, 40 ks with UVEX (top) and COS G140L (bottom), both run through current ETCs.

- **Same resolution** (0.58 Å vs. 0.59–0.62 Å per pixel), but UVEX is far more sensitive redward of 1500 Å
- **Continuum S/N**: 6.0 vs. 5.4 (1500 Å); 5.5 vs. 1.0 (1800 Å)
- **One exposure** covers 1150–2800 Å where COS needs two gratings; C III] $\lambda 1909$ measurable to $z \approx 0.47$ (vs. $z \lesssim 0.05$ with COS)
- **2" × 1° long slit** captures extended emission that COS's 2.5" aperture misses

~30×

COS requires more exposure time at 1800 Å

2–20×

the COS G140L effective area at 1490–1900 Å

≥ 25

LMLZ galaxies with C/O in the baseline mission

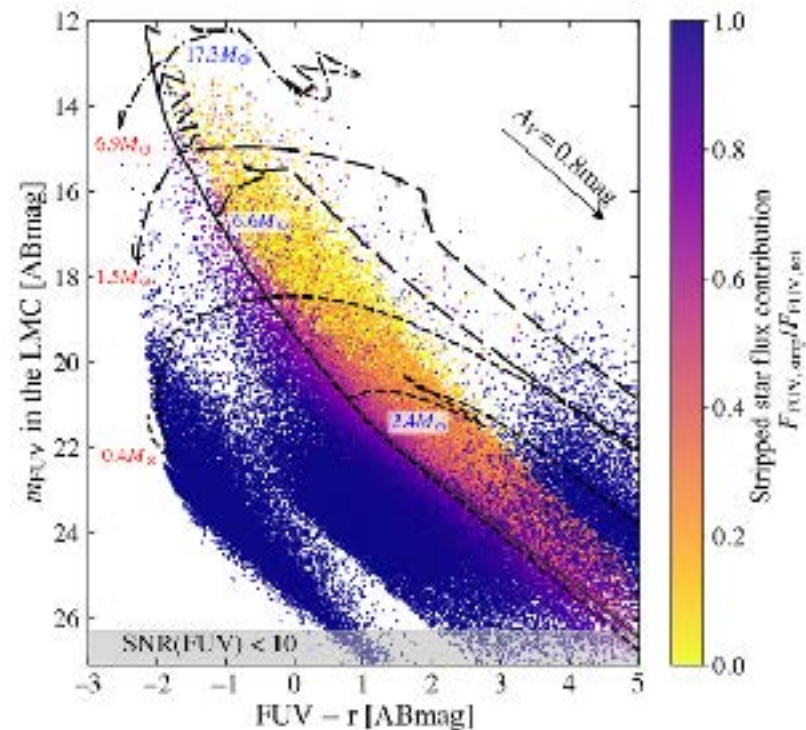
Goal 1: Massive and Stripped Stars in the Magellanic Clouds

Formation of a Stripped star

(credit: Ylva Götberg)



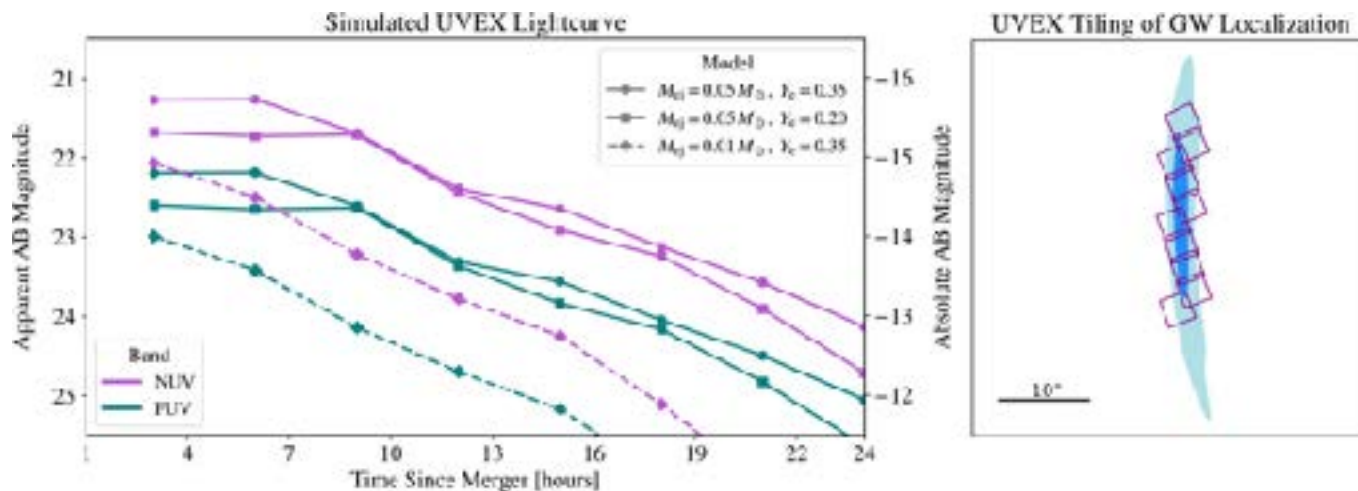
- **Cadenced imaging** of $\geq 50 \text{ deg}^2$ (LMC) and 18 deg^2 (SMC) to $\sim 27 \text{ mag}$ (FUV and NUV) in ~ 80 epochs
- **Stripped stars:** binary-stripped stars are hot, UV-bright and optically-faint; UVEX will identify a population spanning $\sim 0.35\text{--}8.5 M_{\odot}$ via FUV excess and eclipsing UV light curves
- **Science Impacts:** progenitors of stripped-envelope SNe, X-ray binaries and GW mergers; the ionizing budget of binaries



Simulated FUV - r color-magnitude diagram of the LMC; color shows the stripped-star contribution to the FUV light. About half of stripped-star binaries sit $> 5\sigma$ bluer than the main sequence.

Goal 2: Neutron Star Mergers in the UV

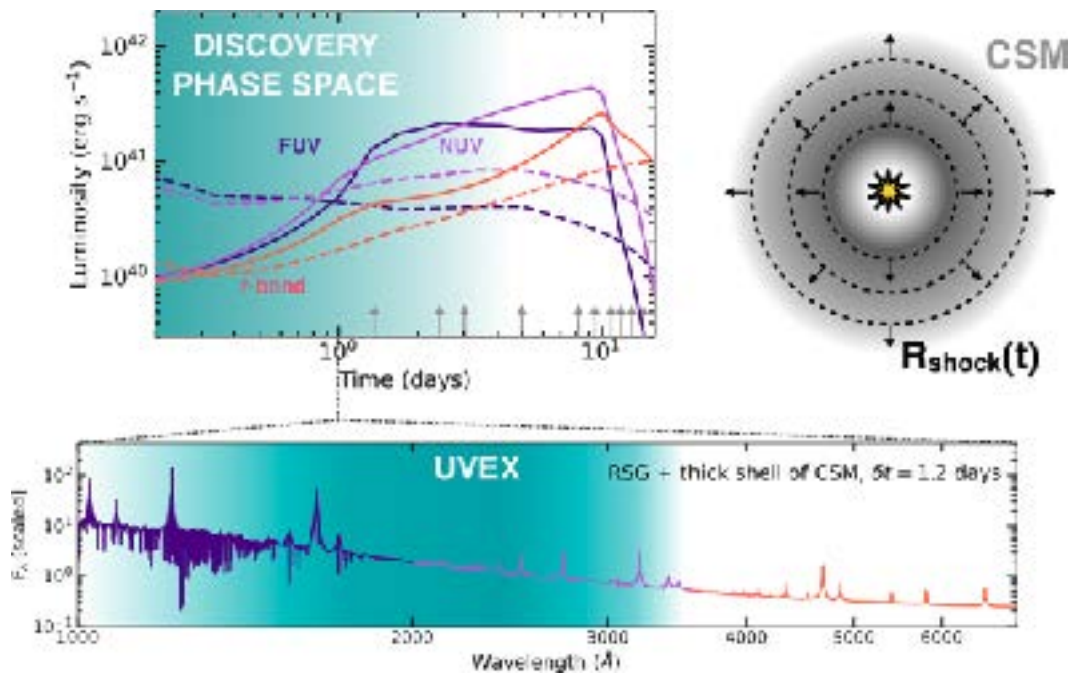
- **Rapid two-band tiling** of LIGO/Virgo/KAGRA O5 BNS and NSBH localizations starting < 6 hr post-merger
- **Spectroscopic sequences** over the first day if a counterpart is found (by UVEX, ULTRASAT or others) at < 12 hr
- **Expected yield:** ~15 events followed up; ~6–9 kilonova detections — early UV distinguishes shock-powered from radioactively powered ejecta and constrains the fast, blue component



Left: predicted NUV/FUV kilonova light curves at 250 Mpc for different ejecta masses and lanthanide fractions. Right: an optimized UVEX tiling of a GW skymap.

Goal 2: The First UV Spectra of Infant Supernovae

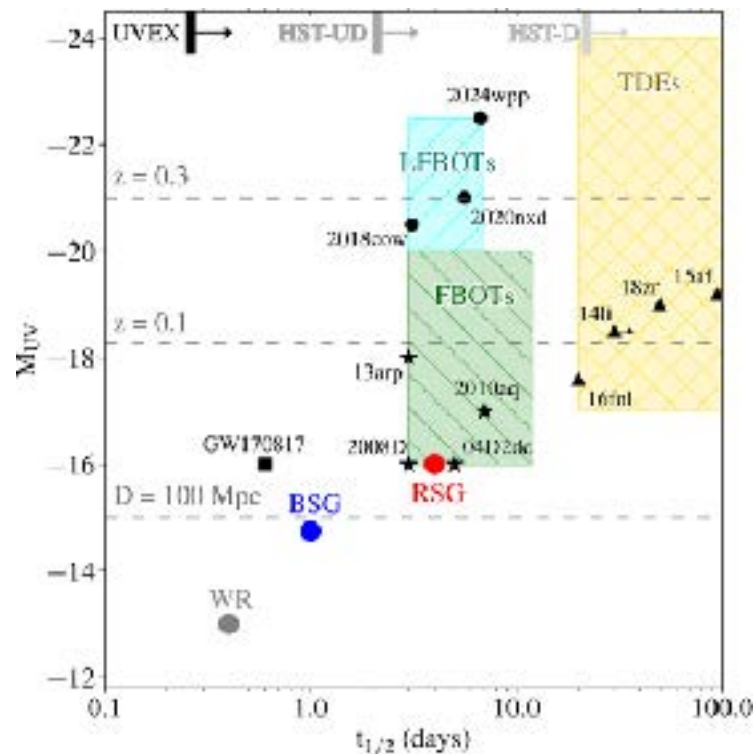
- **The first day of most explosions peaks in the UV** — no UV spectrum exists before ~1.5 days
- **Plan:** Spectral sequences starting < 6 hr after trigger for ≥ 10 supernovae within ~100 Mpc
- **Science:** The progenitor's final mass loss (confined CSM) and the composition and structure of the exploding star, read from rapidly evolving UV lines
- **Triggers** from Rubin, ULTRASAT, ground-based surveys, and UVEX's own all-sky survey



Top: FUV/NUV/r light curves of a red-supergiant explosion with (solid) and without (dashed) a dense CSM shell; arrows mark all existing early UV spectra. Bottom: simulated UVEX spectrum at 1.2 days.

Goal 2: The Community ToO & Time Domain Program

- **8% of the mission** (58 days) for community-identified ToOs and time-domain spectroscopy — vs. ~2% of HST for UV spectroscopic ToOs and < 1% for disruptive (< 21 d) ones
- **Response** as fast as < 6 hr when needed (average < 3 hr to target); ~20 rapid ToOs per year
- **Targets:** TDEs (only 5 UV spectra exist), FBOTs and luminous FBOTs (one UV spectrum exists), shock-cooling emission from young SNe, novae, stellar flares, CVs...
- **Triggers from UVEX itself:** The all-sky survey should find ~20 TDEs, up to 10 LFBOTs and ~50 SLSNe per year bright enough ($m < 20$) for spectroscopy



UV transient phase space (peak NUV magnitude vs. time above half-max). Ticks compare UVEX response to HST disruptive (D) and ultra-disruptive (UD) ToOs.

Goal 2: The Community ToO & Time Domain Process



Allocation is programmatic — time goes to categories of sources, not to individual PIs.

More details at the AAS winter meeting: UVEX Town Hall --- Tuesday January 12, 2027.

Goal 3: A Deep, Cadenced All-Sky UV Survey

- **Coverage:** The entire sky, including the Galactic Plane, in FUV and NUV simultaneously
- **Depth:** ~23.5–24.5 AB per visit; stacked ≥ 24.25 (FUV) / 25.25 (NUV) AB outside the Plane
- **Cadence:** 3–10 visits per field spanning hours to months to years — sensitive to flares, novae, TDEs, SNe, AGN variability, ...
- **Bonus:** The spectrograph exposes in parallel, yielding the largest UV spectral dataset ever
- **Alerts:** Transients found by difference imaging, broadcast to everyone within 1 hr of data receipt

>50-100×

deeper than the GALEX all-sky survey in the FUV and NUV

2×

sharper PSF than GALEX

+14,000 deg²

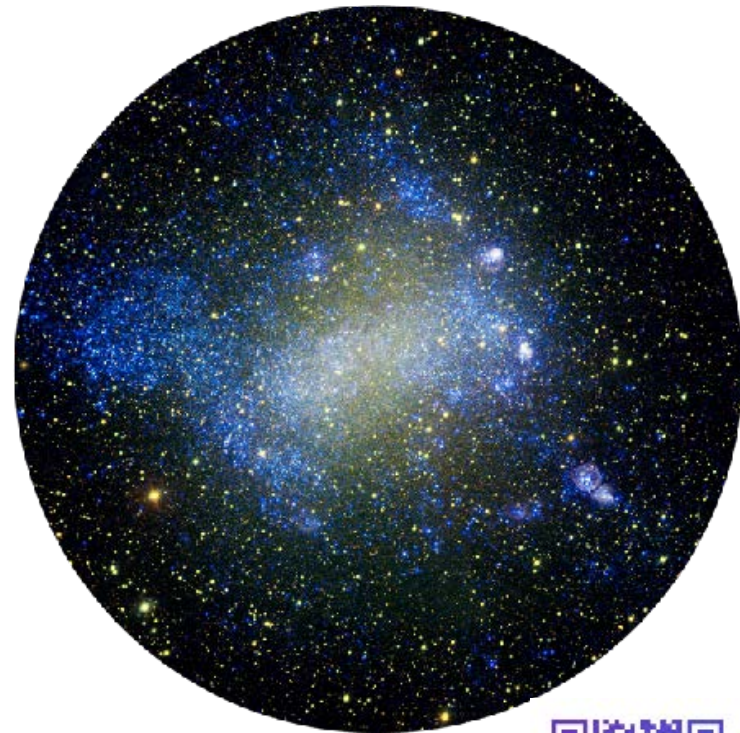
of new sky coverage, including the Galactic Plane

0 days

proprietary period; images released daily

Summary

- **UVEX launches in 2030:** Wide-field FUV + NUV imaging, sensitive long-slit UV spectroscopy, and rapid response
- **Two-year baseline science:** The low-mass galaxy frontier, the dynamic UV universe, and a cadenced all-sky survey $> 100\times$ deeper than GALEX
- **The UV complement** to Rubin, Euclid, Roman, JWST, LIGO O5 and ULTRASAT — and a bridge to HWO
- **For the community:** 8% of time for ToOs and time-domain shaped by your white papers; public alerts; daily data releases; no proprietary period
- **Learn more:** UVEX Town Hall at the AAS winter meeting, January 12, 2027



UVEX Concept paper: Kulkarni+ (2021)
UVEX Mission paper: Harrison+ (submitted)