MUSTI - A Massive stars far-Ultraviolet, Spectroscopic and TIme domain mission

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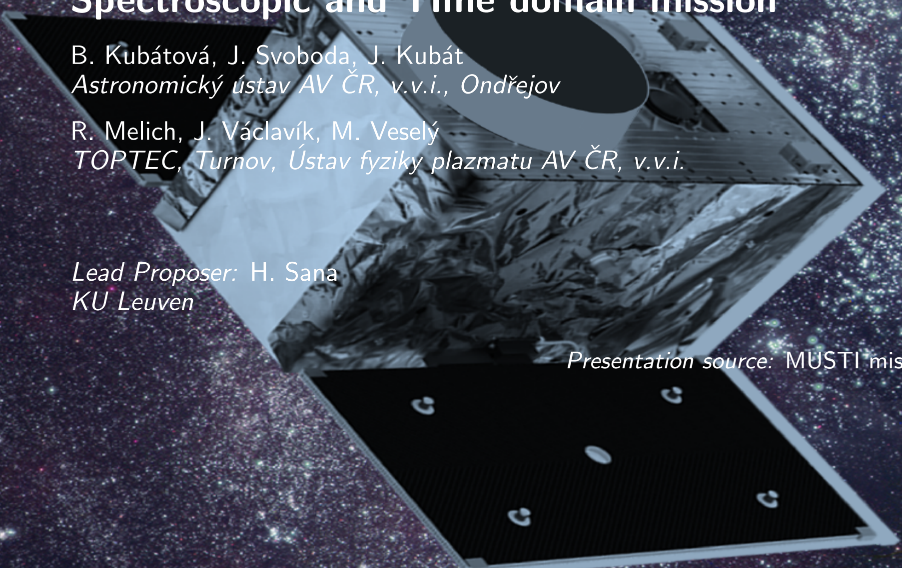
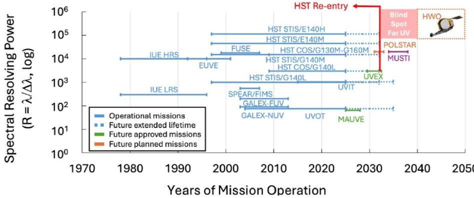
Presentation source: MUSTI mission proposal



Scientific context of MUSTI

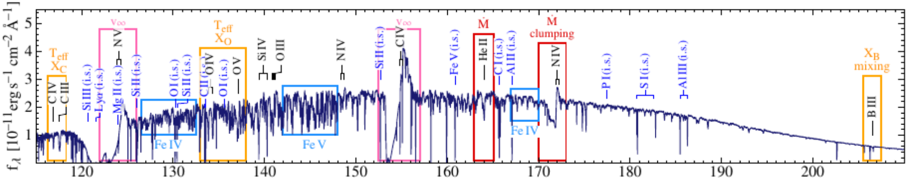
- Massive stars dominate radiative feedback, chemical enrichment, compact-remnant formation and gravitational-wave progenitor channels.
- The **far-ultraviolet** contains decisive diagnostics of hot-star atmospheres, radiatively driven winds and stripped binary products.
- High-resolution access to this range is at risk in the **post-HST era**; most upcoming UV missions emphasise photometry or low-resolution spectroscopy.



Overview of space missions with FUV spectroscopic capabilities

MUSTI preserves a scarce capability: high-resolution FUV spectroscopy after HST.

Primary science case I: massive-star atmospheres

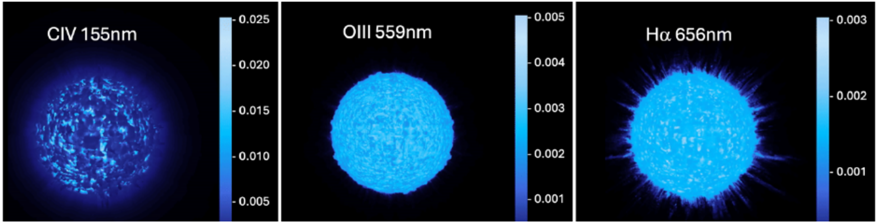


Key FUV diagnostics across 120–210 nm: C, N, O, Fe and B.

- FUV resonance lines directly constrain **mass-loss rates**, terminal wind speeds and atmospheric abundances.
- Joint abundance diagnostics (especially **B, C, N, O**) disentangle rotational mixing from binary interaction and mergers.
- MUSTI Core Survey #1 targets >**200 OB stars and** >**50 WR stars** at S/N > 50 and $R \sim 20{,}000$.

FUV spectra calibrate massive-star abundances, winds and evolution

Primary science case II: dynamics of massive-star winds

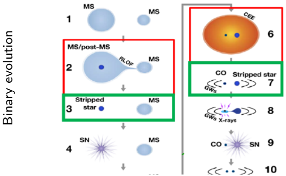


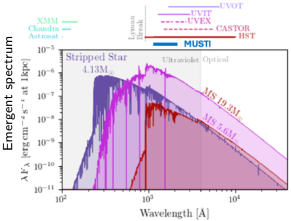
3D simulations show that FUV wind diagnostics have much higher contrast than optical lines.

- Massive-star winds are **structured and time-variable**; clumping can bias single-epoch mass-loss determinations.
- High-cadence FUV spectroscopy is required to test modern **3D wind simulations** and recover the relevant dynamical parameters.
- MUSTI Core Survey #2 follows about **50 OB and WR stars** over hours to weeks, with repeated observations of Goal 1 targets.

Time-series FUV spectra map clumping and wind variability.

Primary science case III: Galactic massive stripped stars





- Stripped stars are binary-interaction products and likely progenitors of **H-poor supernovae** and compact-object binaries.
- They are **FUV bright but optically faint**; high-resolution FUV spectroscopy is the decisive discovery and characterisation channel.
- MUSTI Core Survey #3 targets >**50 Galactic stripped stars**, including radial-velocity monitoring for binary masses and multiplicity.

FUV diagnostics reveal stripped-star masses, binaries and fates.

Complementary core science cases enabled by MUSTI

Classical Be stars
Origin of decretion disks, mass loss and hot stripped companions; the programme includes >100 Galactic Be stars and monitoring of disk build-up / dissipation events.

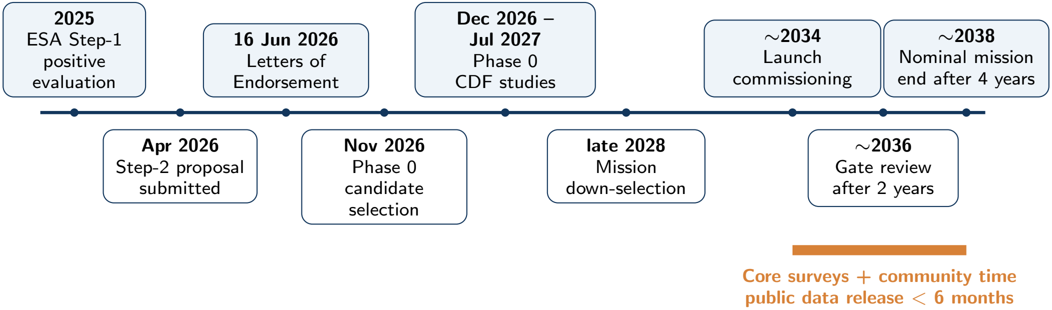
Young stars and planet formation
FUV diagnostics of accretion, winds, photoevaporation and the stellar UV radiation field in a coeval star-forming region.

Hot subdwarfs (sdB/sdO)
Diffusion, radiative levitation and weak winds in low-mass stripped-star analogues; about 80 targets plus multi-epoch binary follow-up.

Interstellar medium
Absorption-line diagnostics and FUV extinction curves along nearly every MUSTI sightline, yielding a major homogeneous Galactic ISM dataset.

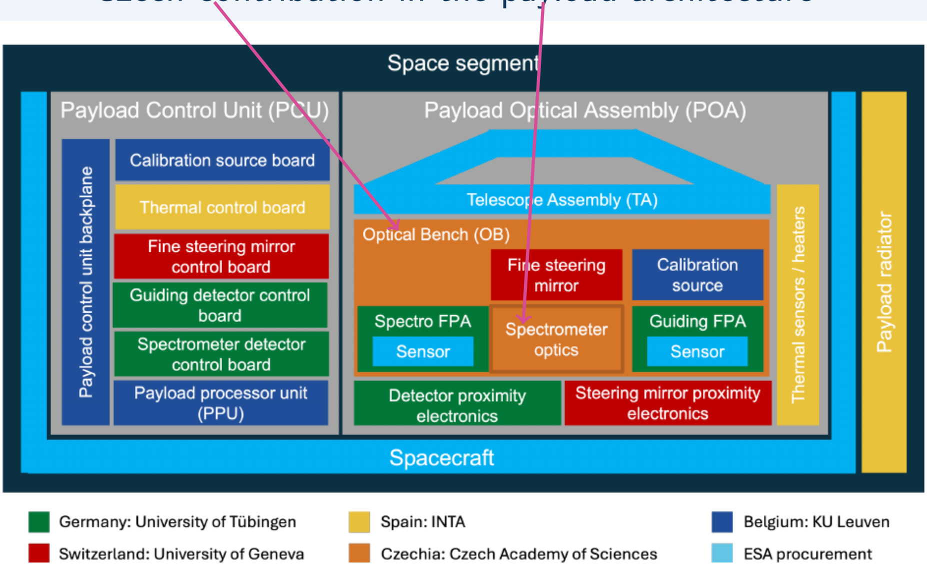
FUV surveys extend MUSTI science to Be stars, sdBs, disks and interstellar medium.

Mission timeline: proposal, selection and mission phases

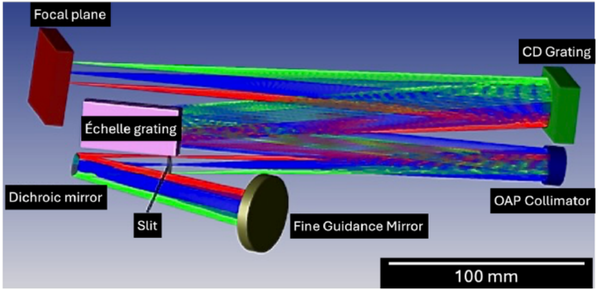


- **2026 milestones:** proposal submission, Letters of Endorsement, and selection for Phase 0 candidates.
- **Mission anchor points from MUSTI:** launch around 2034, gate review after 2 years, nominal duration 4 years.

Czech contribution in the payload architecture



Spectrograph concept, optical bench



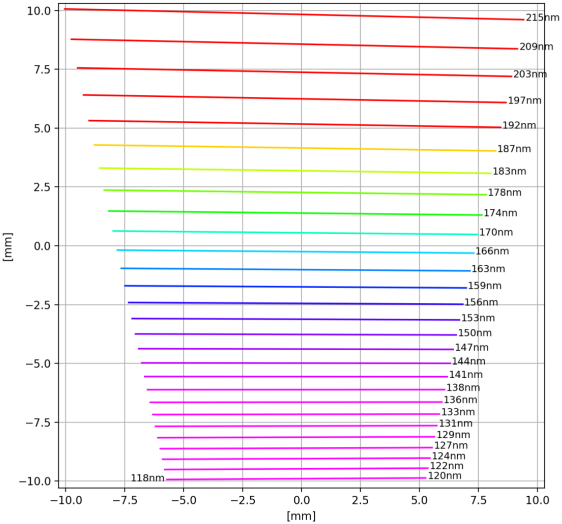
Spectrometer

- échelle grating: 180 grooves/mm, blaze angle 63°.
- $R \approx 20\,000$
- 120 – 210 nm
- 28 spectral orders
- cross-dispersion: aberration-corrected spherical concave grating
- mirror coatings: $AlMgF_2$ (same as the telescope)

Optical bench

- near-zero CTE
- minimum weight

Spectrograph concept, optical bench



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Summary

- **Scientific case:** MUSTI will provide **high-resolution far-UV spectroscopy in the time domain** for massive stars, preserving a capability that will be largely unavailable in the post-HST era.
- **Mission drivers:** the core science translates directly into the need for **120–210 nm coverage**, $R \approx 20{,}000$, high throughput, and cadences from **hours to months**.
- **Czech role:** the Czech team is responsible for the **spectrometer and optical bench**, i.e. for the subsystem that converts the science requirements into the delivered optical performance.
- **Value of participation:** MUSTI combines strong astrophysical impact with a **visible, technically substantial Czech hardware contribution** and clear heritage building for future ESA missions.

Take-home: MUSTI is a scientifically timely mission with a clearly defined and technically meaningful Czech contribution.

Source: MUSTI mission proposal