

# Galaxy Evolution Spectroscopic Explorer (GESE): A **UV/Optical/Near-IR** Spectroscopic Sky Survey For Understanding Galaxy Evolution

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## Outline of Talk

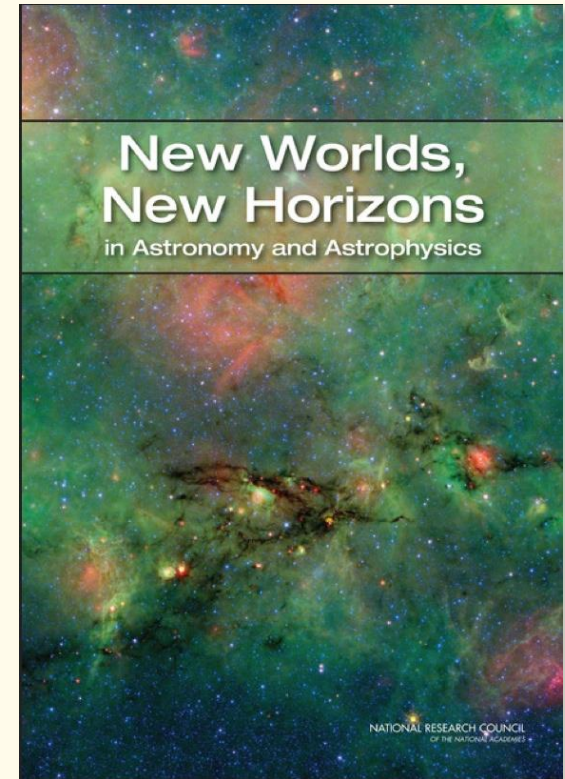
1. Scientific rationale
2. Formulation of mission concept
3. The GESE mission concept
4. European component of GESE?

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# Astro2010

“While we have a rather good description of the properties of galaxies in the present-day universe, we have far less information about how these properties have changed over the ...history of the universe.

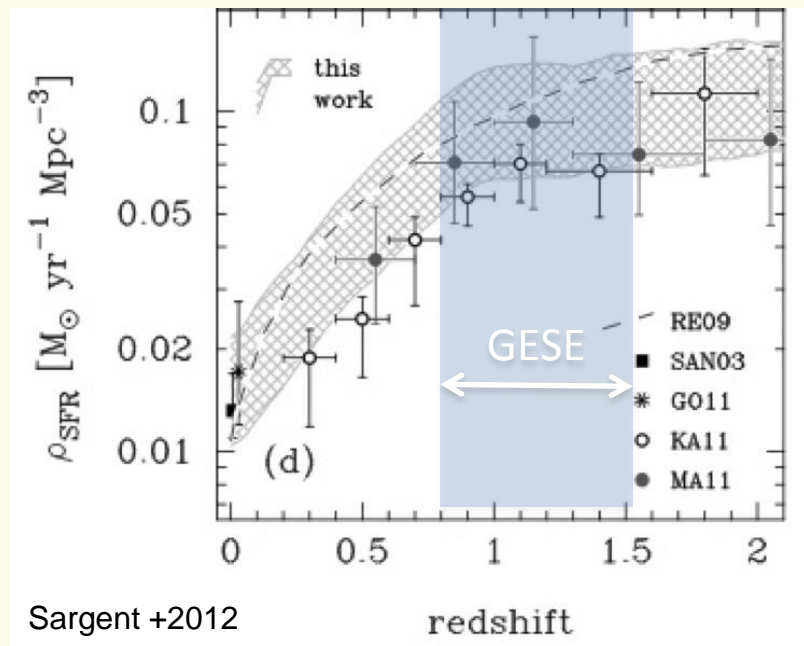


“A high priority in the coming decade will be to undertake **large and detailed surveys of galaxies** as they evolve across the wide interval of cosmic time—to have a movie of the lives of galaxies rather than a snapshot” ...Astro2010

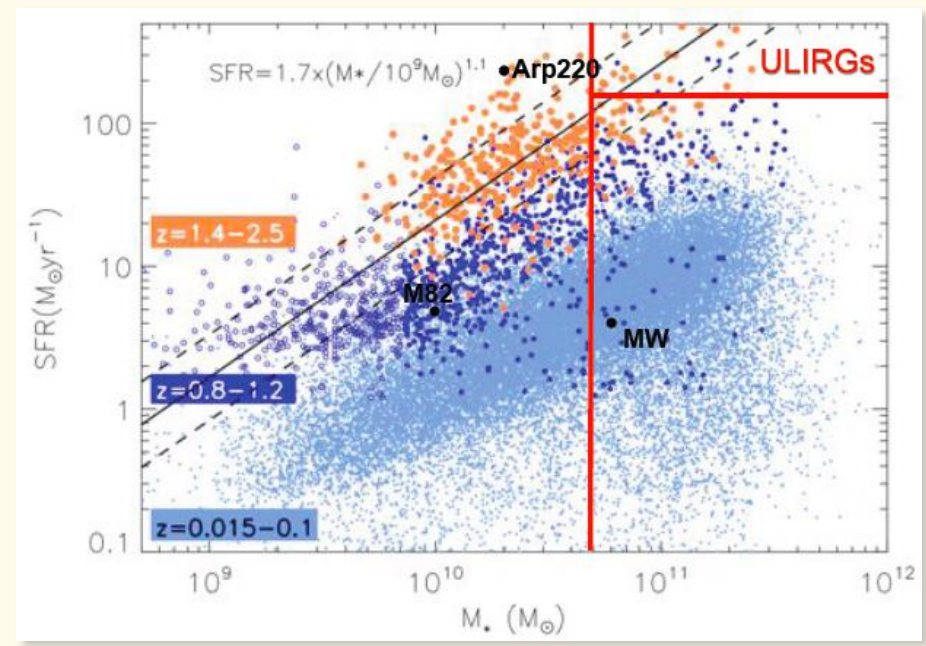
# 1. Scientific Rationale

*Scientific Goal: To understand galaxy evolution at  $z \sim 1$  by*

- Determining the properties of galaxies (stars, gas, dust, AGN) at  $z \sim 1$
- Assessing environmental influences at  $z \sim 1$  (field galaxy vs. galaxy cluster)
- Identifying & measuring processes driving evolution at  $z \sim 1$



Star-Formation history of the universe



Main Sequence of S-F galaxies

# Scientific Investigation

*Measurements to be made: Spectroscopic survey of galaxies at  $z \sim 1$*   $\sim 10^6$

*Why Spectra?* Only spectra can provide:

- accurate redshifts needed to identify high-density regions (clusters),  
to stack spectra of like objects to increase S/N
- properties of stellar population(s)
- sensitivity to flows in/out of galaxies
- physical conditions of the ISM and circum-galactic medium
- identification of accreting black holes

*Why So Many Galaxies?*

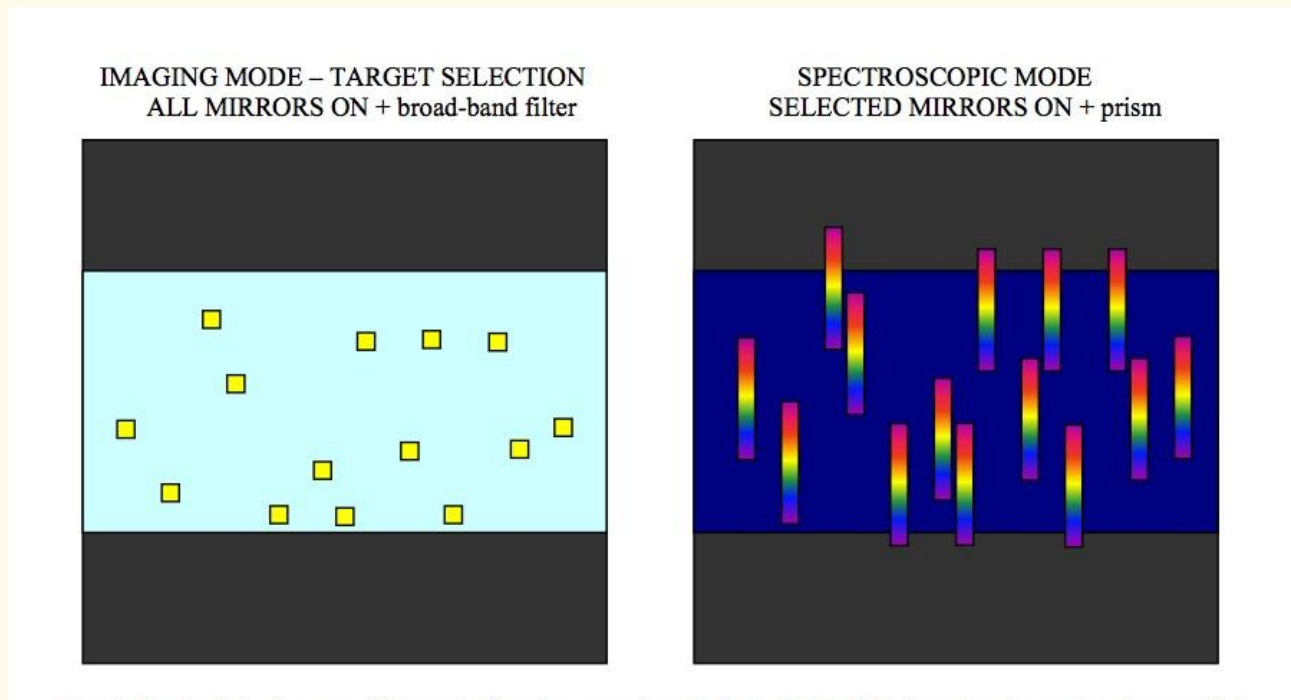
- To distinguish among the processes drivers of galaxy evolution (e.g. accretion, mergers, star formation and stellar feedback, growth of black holes)
- To cover a wide variety of environments that govern star formation.

## Why $z \sim 1$ ?

- $z \sim 1$  corresponds to a  $\sim 8$  billion-year lookback time, i.e. when the universe was only 40% of its current age
- $z \sim 1$  marks the start of the end of the era of high star-formation rates
- $z \sim 1$  is an era that can only be fully surveyed by space telescopes (i.e. with access to the rest far-UV). At  $z \geq 2$ , ground-based telescopes can observe Lyman  $\alpha$  (1216 Å)

## 2. Science Goals → Mission Concept

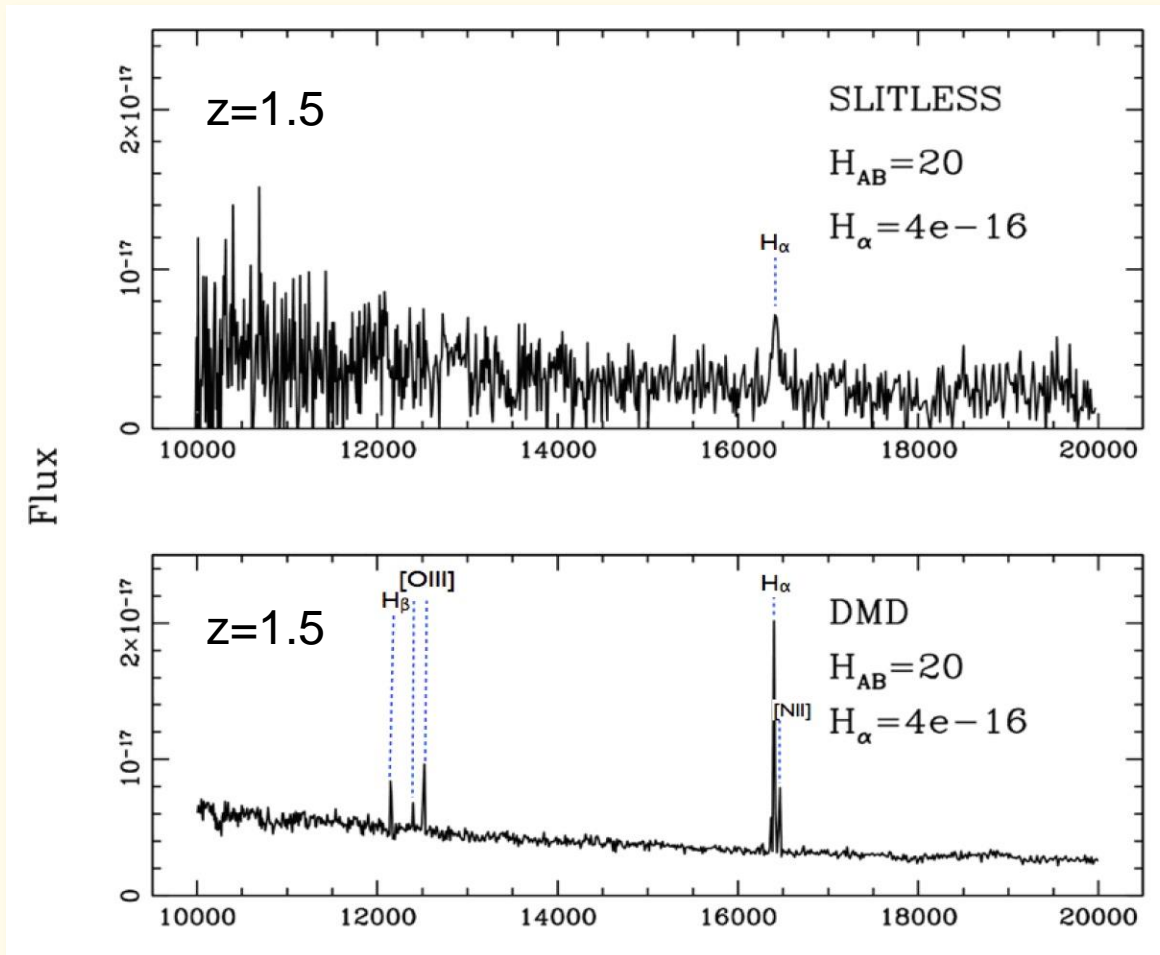
*How to obtain spectra of a million galaxies?*  
Make use of a multi-object slit spectrograph



Robberto et al. (2010) SPIE 72100A

# Why a slit spectrograph?

To block out the zodiacal background → increase S/N

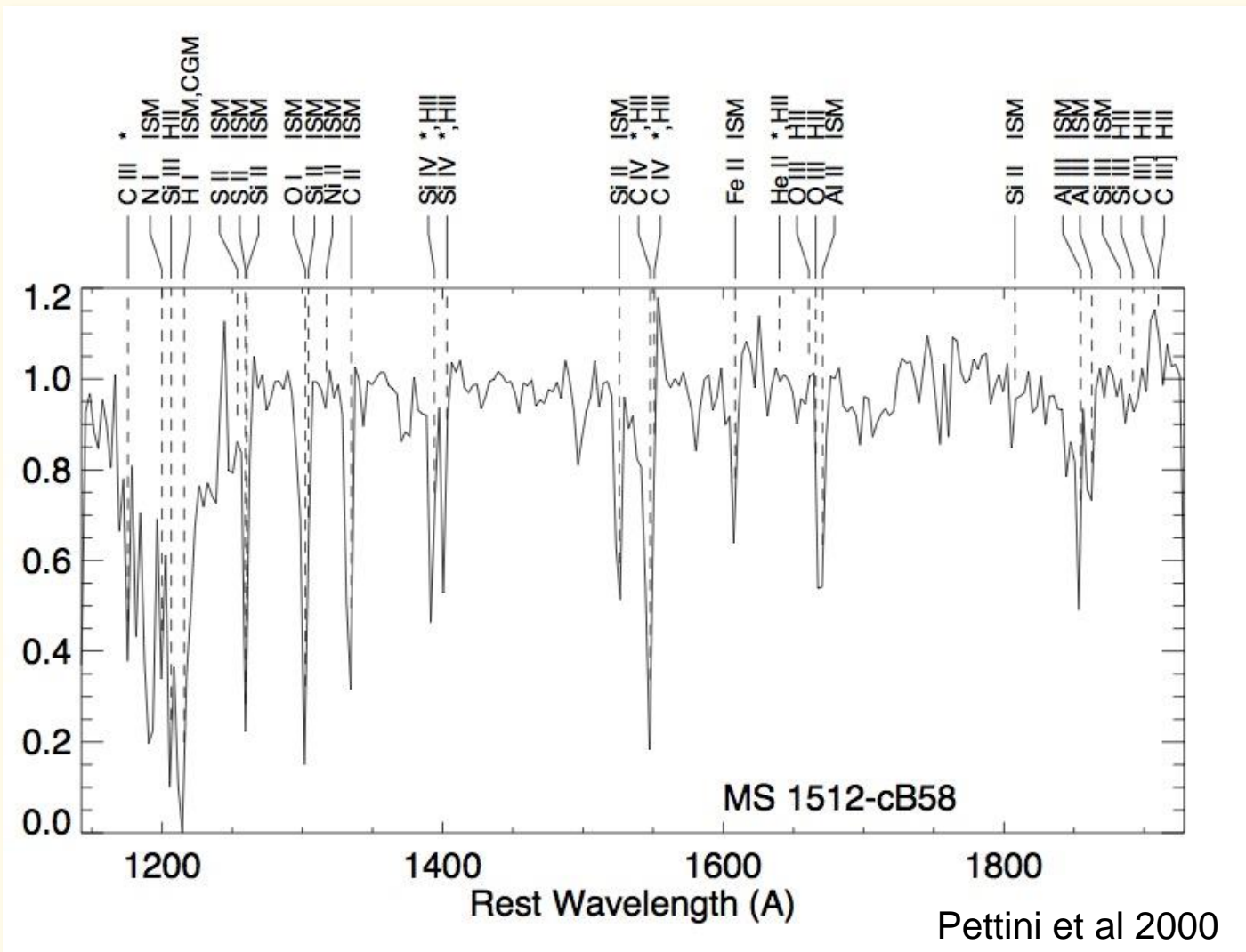


The Euclid Yellow Book (2010)

and to avoid confusion with nearby objects

# Why a Space Telescope?

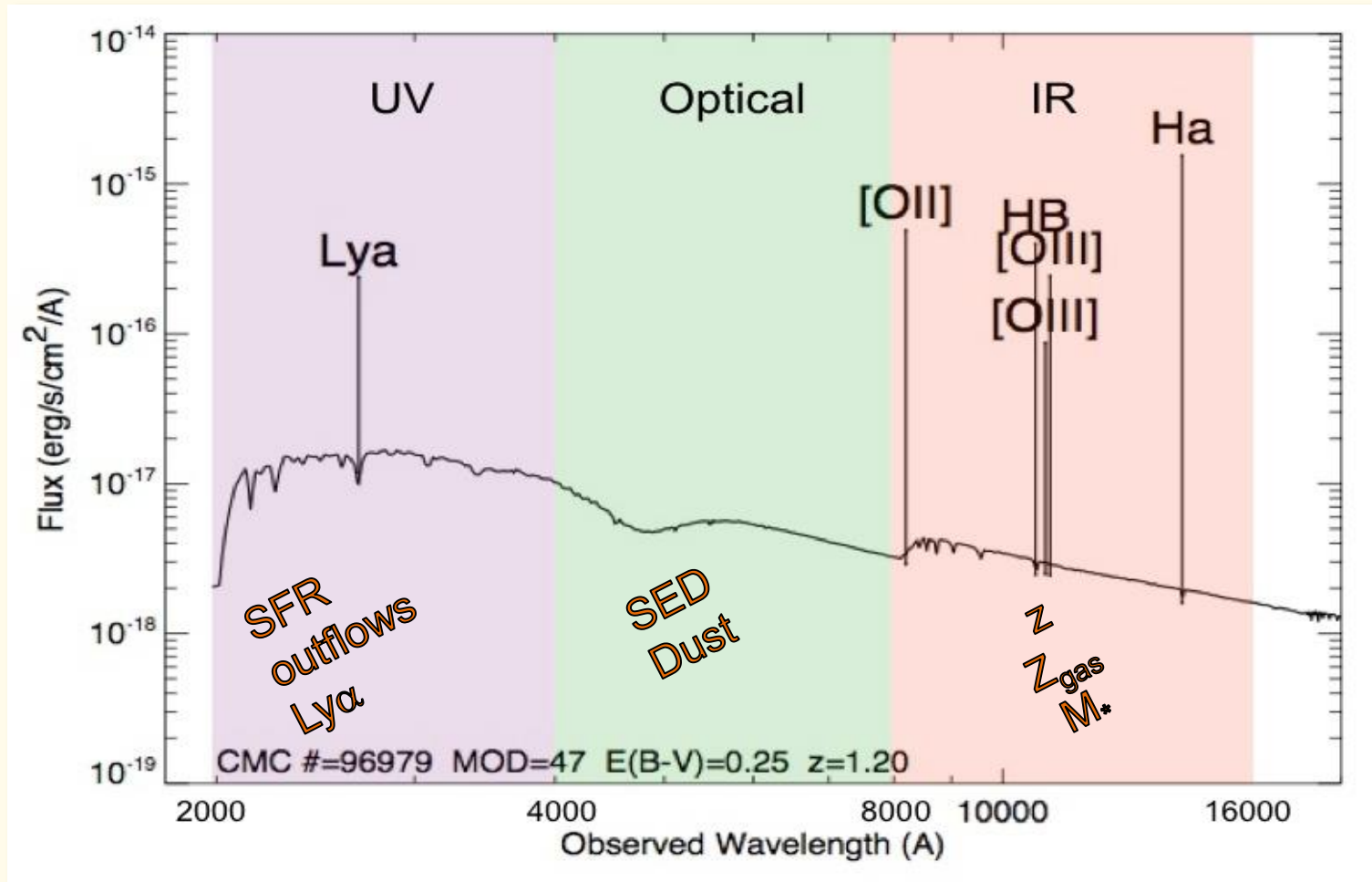
To observe the rest far-UV spectrum, which is rich in diagnostics



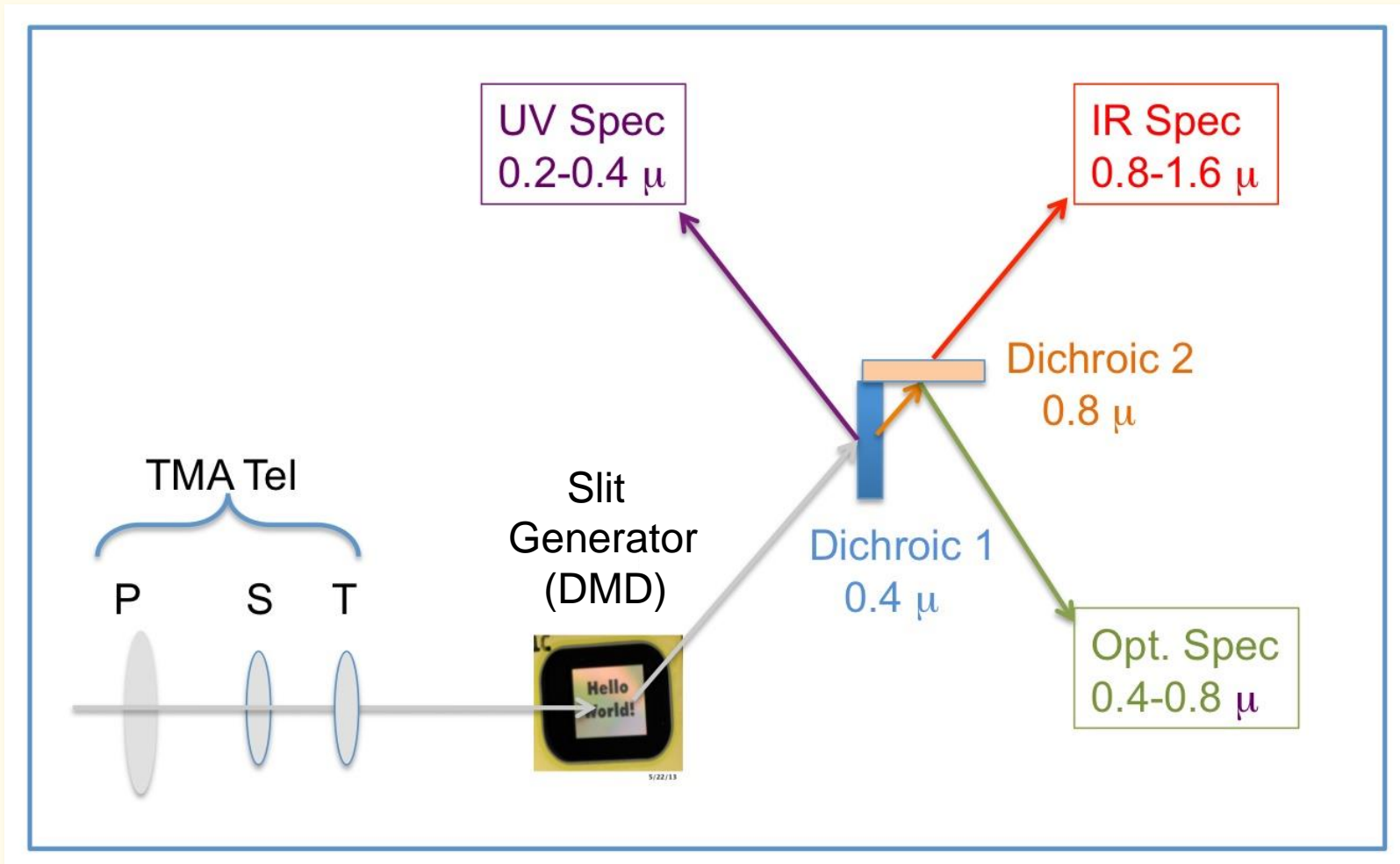


# What spectral regions to observe?

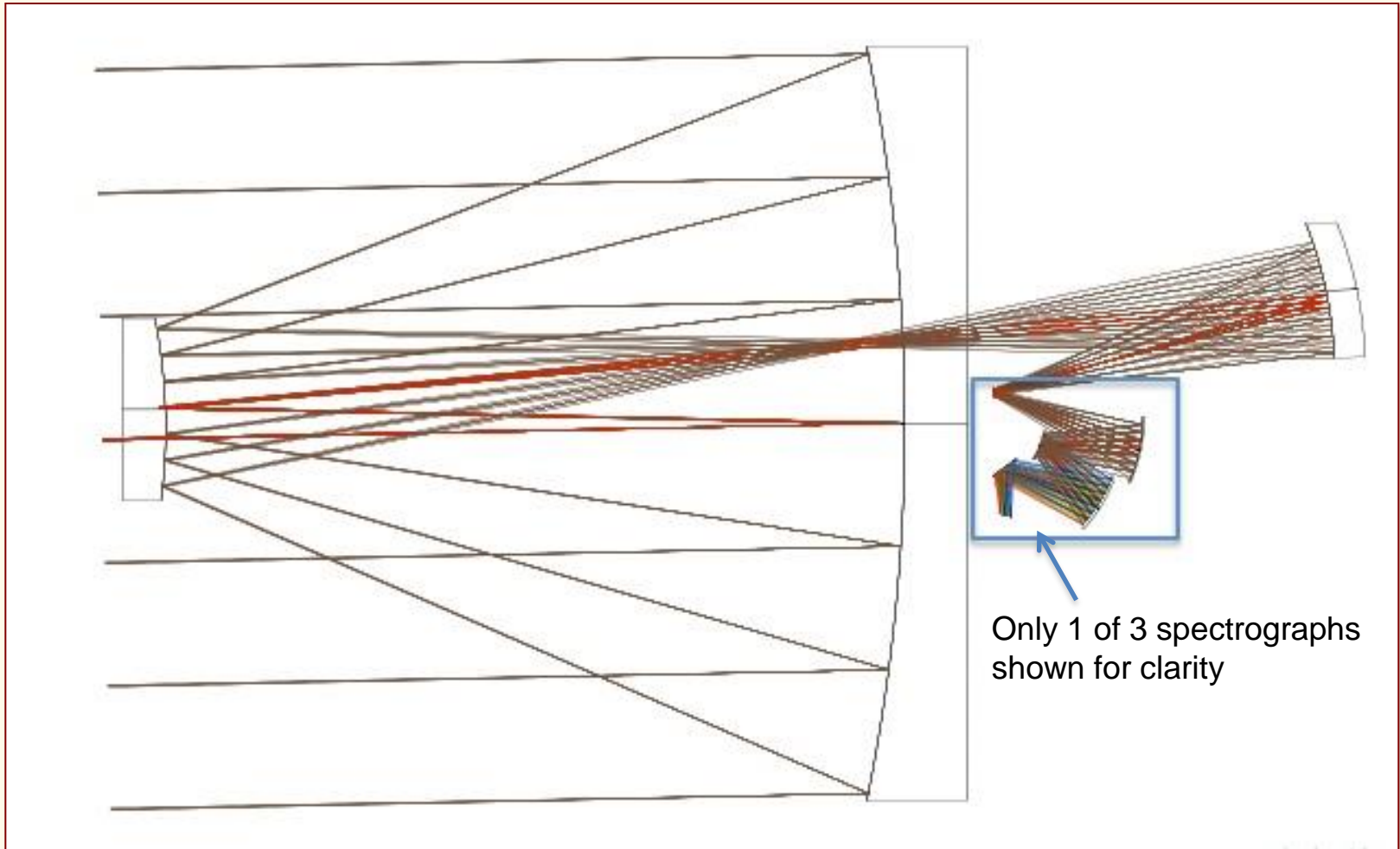
UV (1<sup>st</sup> priority) + Optical + IR



### 3. GESE Instrument Concept



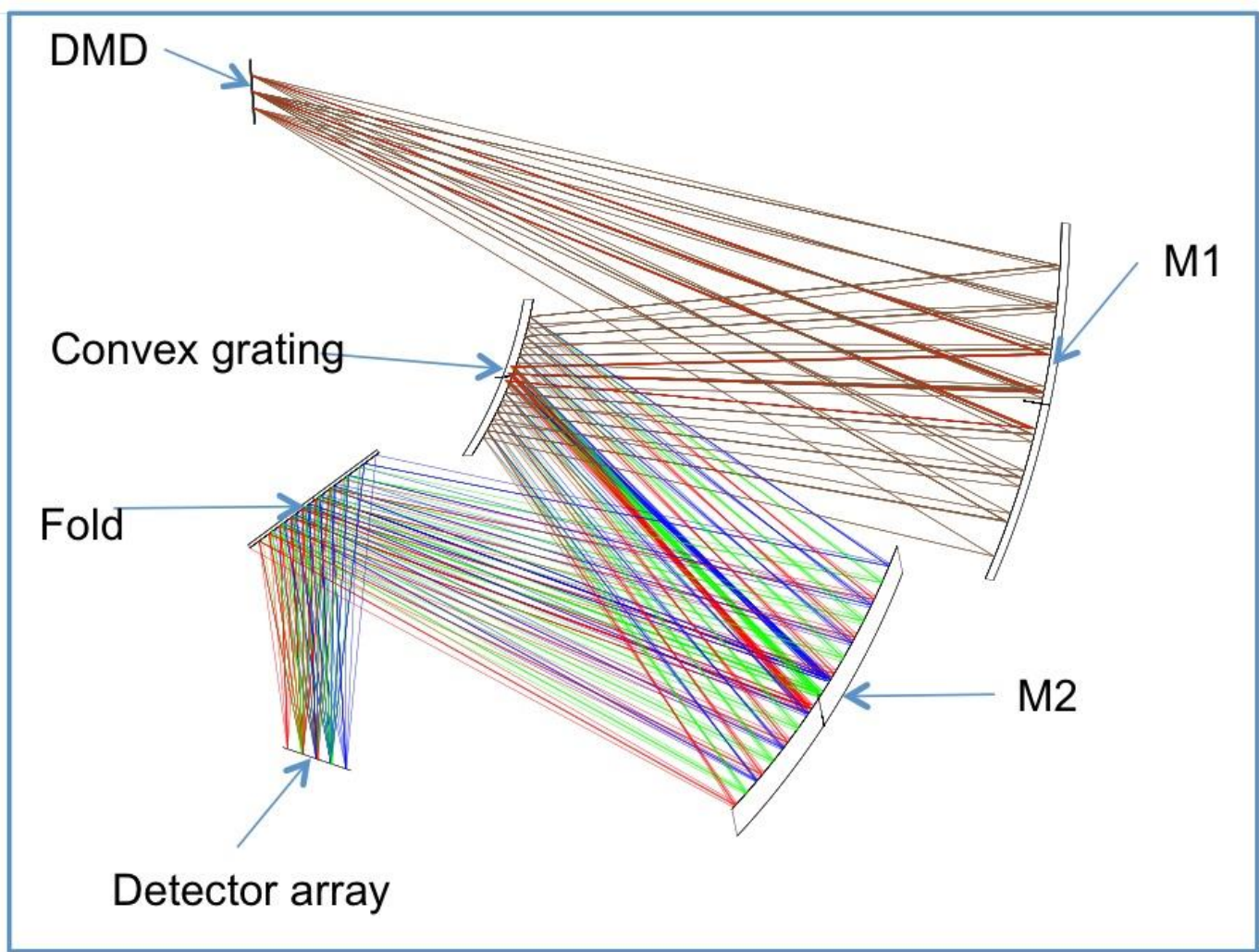
# Instrument Design



1.5-m TMA telescope (f/3.3) with DMD followed by UV, Vis, IR spectrographs

↳ Newest version is f/5

# Spectrograph Design



All 3 spectrographs (UV, optical, IR) are Offner spectrographs

# GESE & EUVO

## GESE is a precursor to EUVO

- Small telescope,  $D_{\text{tel}} \sim 1.5$  m
- Existing components  $\rightarrow$  can get started now
- Affordable

## GESE is a complement to EUVO

- Wide field of view
- Large samples of spectra of  $z \sim 1$  galaxies

# Long History of ESA-NASA Partnership for UV Astronomy

## International Ultraviolet (IUE)

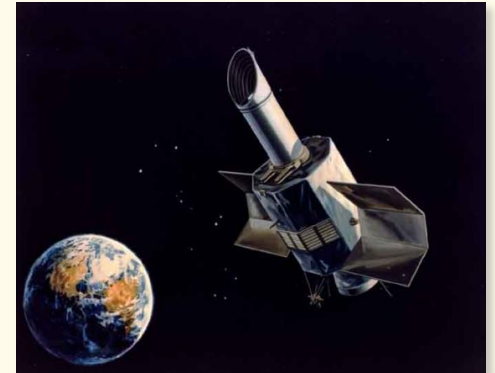
**1978-1996 NASA-ESA-SERC**

- HiRes & LoRes FUV spectra
- HiRes & LoRes NUV spectra

## Hubble Space Telescope

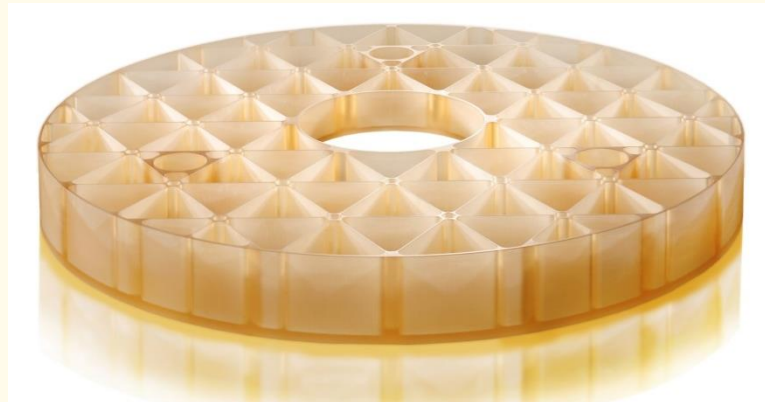
**1990- NASA-ESA**

- FOC FUV & NUV + optical images
- GHRS FUV & NUV spectra
- STIS FUV & NUV + optical spectra
- WFC3 UVIS grism spectra



# Large European Component of GESE Already: GESE Telescope

- Light-weighted telescope from Schott AG (Mainz, Germany)  
Hull, “Lightweight Zerodur”, poster paper, this conference  
Hull+2012, “Game-changing approaches to affordable advanced  
lightweight mirrors II”, SPIE, 8450



Actual 1.2m flight-like lightweight mirror in ZERODUR® fabricated by Schott and first displayed in January 2013 at the AAS Meeting. This mirror could be duplicated in 2 months at a cost under \$700K.



# Large European Component of GESE Already: GESE Slit Spectrograph



## DMD (Digital Micromirror Device) Slit Generator

- DMD performance & environmental testing by LAM and ESA

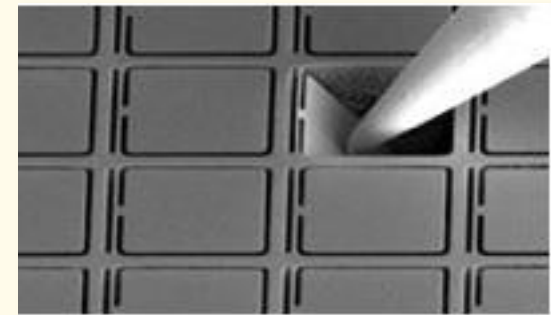
Zamkotsian+2012, "MOEMS devices ... for astronomical instrumentation in space," SPIE, 8250

- GESE-like instrumentation and operation on Galileo telescope

Zamkotsian+2012, "BATMAN: a DMD-based MOS demonstrator on Galileo Telescope," SPIE, 8446

## MSA (Microshutter Array) Slit Generator

- MSA developed by Goddard
- MSA incorporated in ESA's NIRspec on JWST



**Breaking News!**

Next-Generation MSA would be perfect for GESE!

Stay tuned!



~~THE END~~

THE BEGINNING OF GESE

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