Euclid-WEAVE Synergy & first *Euclid* emission line maps

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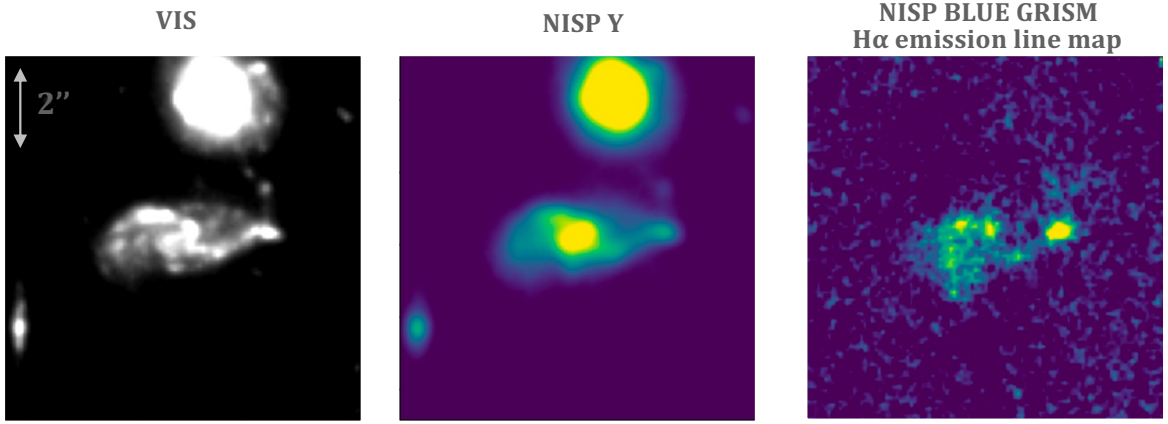
Collaborators:
Chiara Mancini, Benjamin Granett, Gavin Dalton, Angela Iovino, Amata Mercurio + Marcella Longhetti + Margherita Talia + Euclid/GAEV/WP2 + WEAVE/StePS



Durham, 11 July 2025

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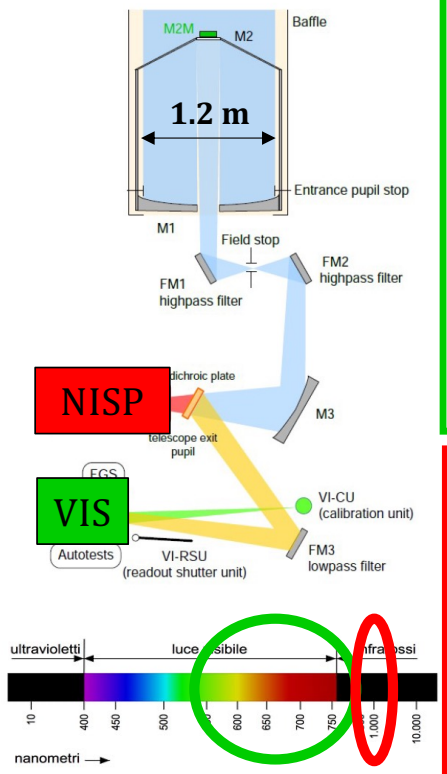
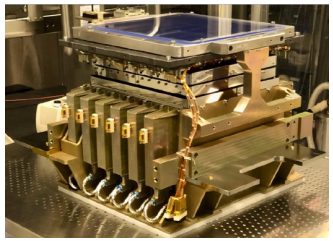
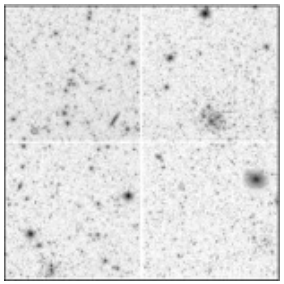
The *Euclid* Mission:
Study of **Dark Energy** and **Dark Matter up to z ≈ 2**

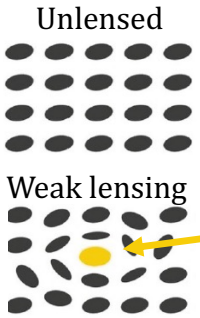


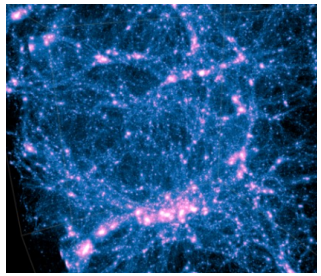
➢ **VIS ➔ Weak Lensing for 3D Dark Matter map ➔ IMAGING**

See Giuseppe's talk!



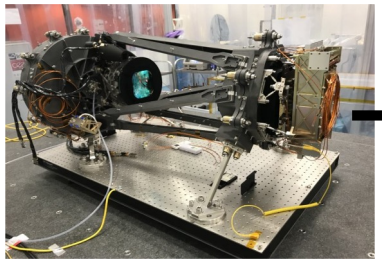


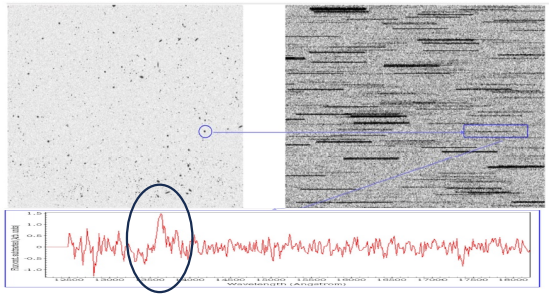


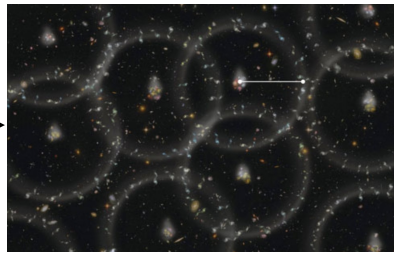


Legacy Science: Morphological parameters for billion of galaxies

➢ **NISP ➔ Redsfhit survey for Dark Energy study ➔ SPECTROSCOPY AND IMAGING**



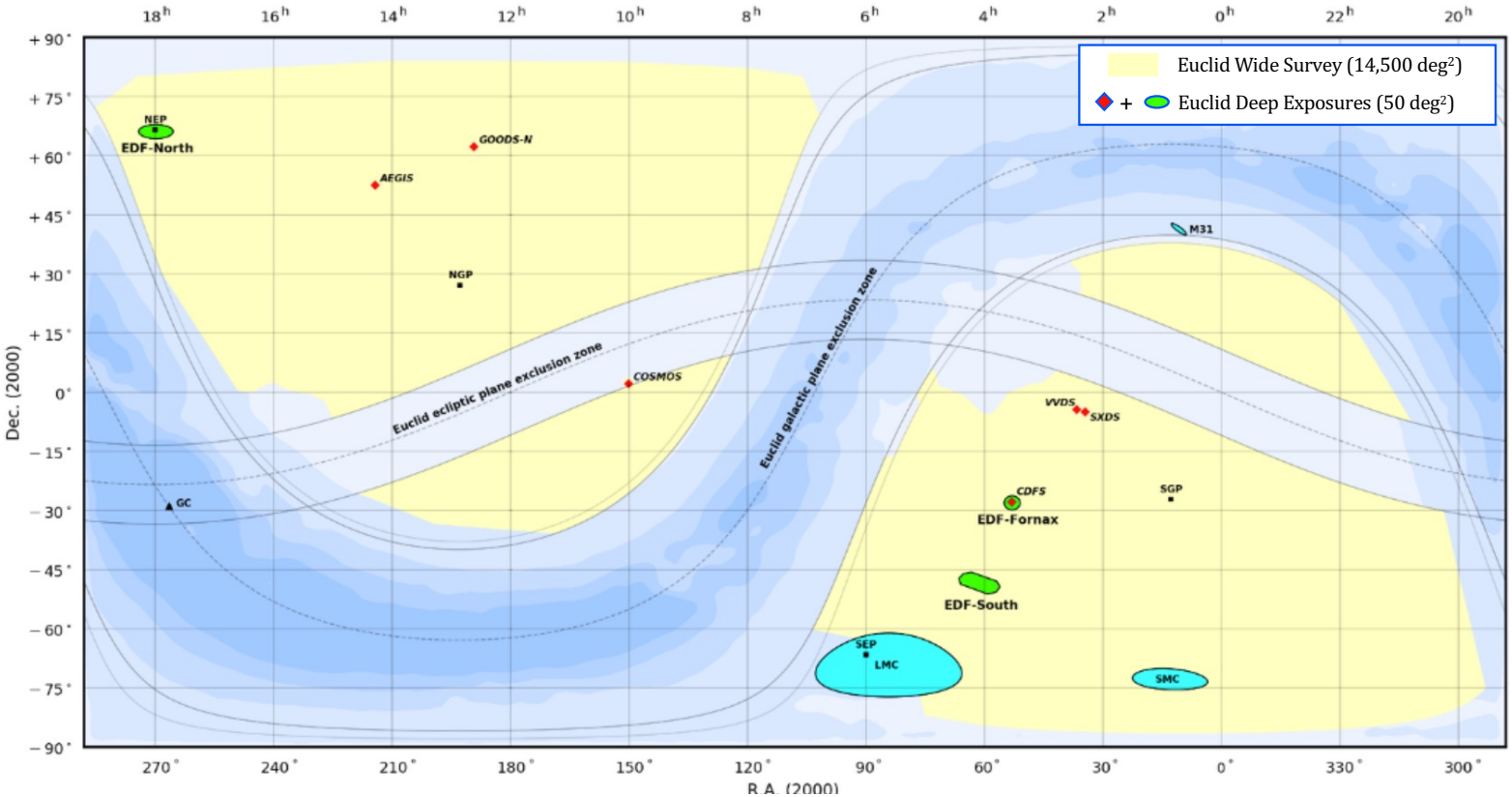




Baryonic acoutic oscillations

Legacy Science: Optical rest-frame spectra for 10s of millions of galaxies

The *Euclid* Wide and Deep Surveys Footprint after the 6-year mission

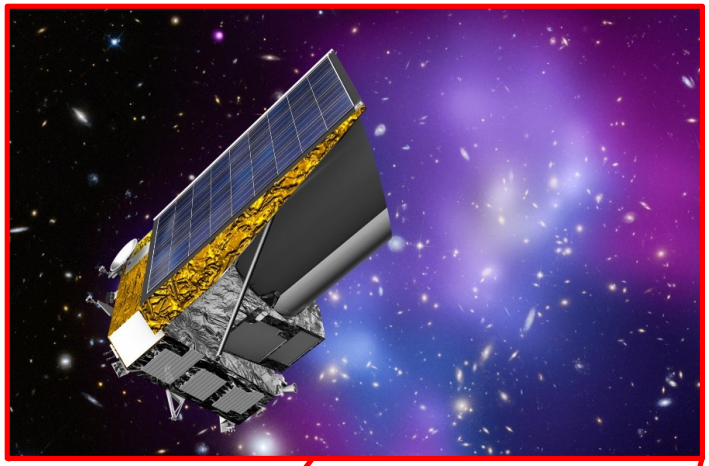


For more info on Q1 Data Release ➔ See Sotiria's talk!

The WEAVE and *Euclid* spectrometers

WEAVE/WHT
Optical fibers
$\lambda/\Delta\lambda \approx 5000$

NISP-S/*Euclid*
Slitless
$\lambda/\Delta\lambda \geq 380$



WEAVE
0.36 to 0.96 um

Blue grism
0.92–1.30 um

Red grism
1.25–1.86 um

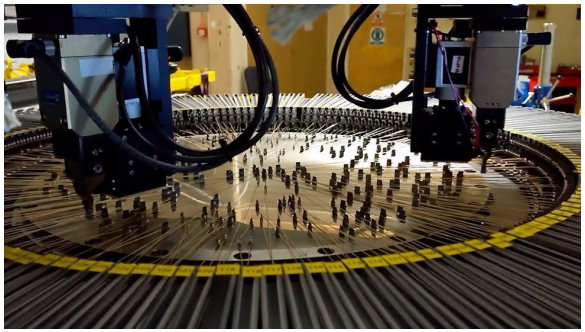
Only used in the *Euclid* Deep exposures

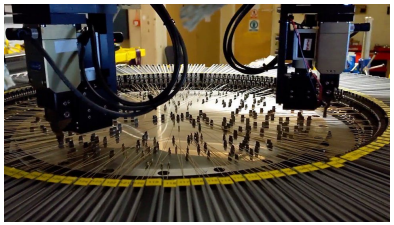
0.36 µm

1.86 um

WEAVE spectrograph on the 4.2m WHT
Los Muchachos, La Palma, Canary Islands

Telescope, diameter	WHT, 4.2m
Field of view	2° ⌀
Number of fibers	960 (plate A)/940 (plate B)
Fiber size	1.3″
Number of small IFUs, size	20 x 11″x12″ (1.3″ spaxels)
LIFU size	1.3′x1.5′ (2.6″ spaxels)
Low-resolution mode resolution	5750 (3000–7500)
Low-resolution mode wavelength coverage (Å)	3660–9590
High-resolution mode resolution	21000 (13000–25000)
High-resolution mode wavelength coverage (Å)	4040–4650 (“blue”) *or* 4730–5450 (“green”) 5950–6850 (“red”)





The WEAVE surveys

WEAVE survey (short-hand)	main targets	number of objects	area (deg^2)	Survey fraction[a]	observing mode(s)	resolution modes(s)	redshift	
Galactic Archaeology (GA-LRhighlat)	MSTO[b] stars, RGB[b] stars, BHB[b] stars, RR Lyrae	$\sim 1.6 \times 10^6$	8750	0.168	MOS	LR	0	Galactic surveys (follow up to GAIA)
Galactic Archaeology (GA-LRdisc)	Red Clump stars, RGB stars	$\sim 1.1 \times 10^6$	1370	0.110	MOS	LR	0	
Galactic Archaeology (GA-HR)	Main sequence & RGB stars	$\sim 1.6 \times 10^6$	5650	0.309	MOS	HR	0	
Galactic Archaeology (GA-OC)	Stars in open clusters and star forming regions	$\sim 1 \times 10^5$	375	0.029	MOS	HR	0	
Stellar, Circumstellar and Interstellar Physics (SCIP)	OBA stars, ionised nebulae, young stars, compact objects	$\sim 4 \times 10^5$	1230	0.069	MOS, LIFU	LR, HR	0	
White Dwarfs	white dwarfs	$\gtrsim 5 \times 10^4$	$\gtrsim 10\,000$	~ 0.012	MOS, mIFU[c], LIFU[c]	LR, HR	0	
WEAVE-Apertif	H I-detected, mostly late-type galaxies	400 (LR), 100 (HR)	0.2[d]	0.061	LIFU	LR, HR	< 0.04	Extra-Galactic surveys
WEAVE Galaxy Clusters	galaxies in dense environments	$\sim 2 \times 10^5$	1350	0.064	MOS, mIFU, LIFU	LR	< 0.5	
Stellar Populations at intermediate redshifts Survey (StePS)	field galaxies	$\sim 2.5 \times 10^4$	25	0.026	MOS	LR	0.3–0.7	
WEAVE-LOFAR	150 MHz sources	$\sim 7 \times 10^5$	8950	0.109	MOS, mIFU, LIFU	LR	< 6.9	
WEAVE-QSO	bright, $r < 21.5$: $z > 2.2$; $21.5 < r < 23.5$: $2.5 < z < 3$[e]	$\sim 4 \times 10^5$	8950	0.056	MOS	LR, HR	> 2.2	

The WEAVE surveys

WEAVE survey (short-hand)	main targets	number of objects	area (deg^2)	Survey fraction[a]	observing mode(s)	resolution modes(s)	redshift
Galactic Archaeology (GA-LRhighlat)	MSTO[b] stars, RGB[b] stars, BHB[b] stars, RR Lyrae	$\sim 1.6 \times 10^6$	8750	0.168	MOS	LR	0
Galactic Archaeology (GA-LRdisc)						LR	0
Galactic Archaeology (GA-HR)						HR	0
Galactic Archaeology (GA-OC)						HR	0
Stellar, Circumstellar and Interstellar Physics (SCIP)						LR, HR	0
White Dwarfs					[c],	LR, HR	0
WEAVE-Apertif						LR, HR	< 0.04
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WEAVE/StePS (Iovino et al. , 2023)

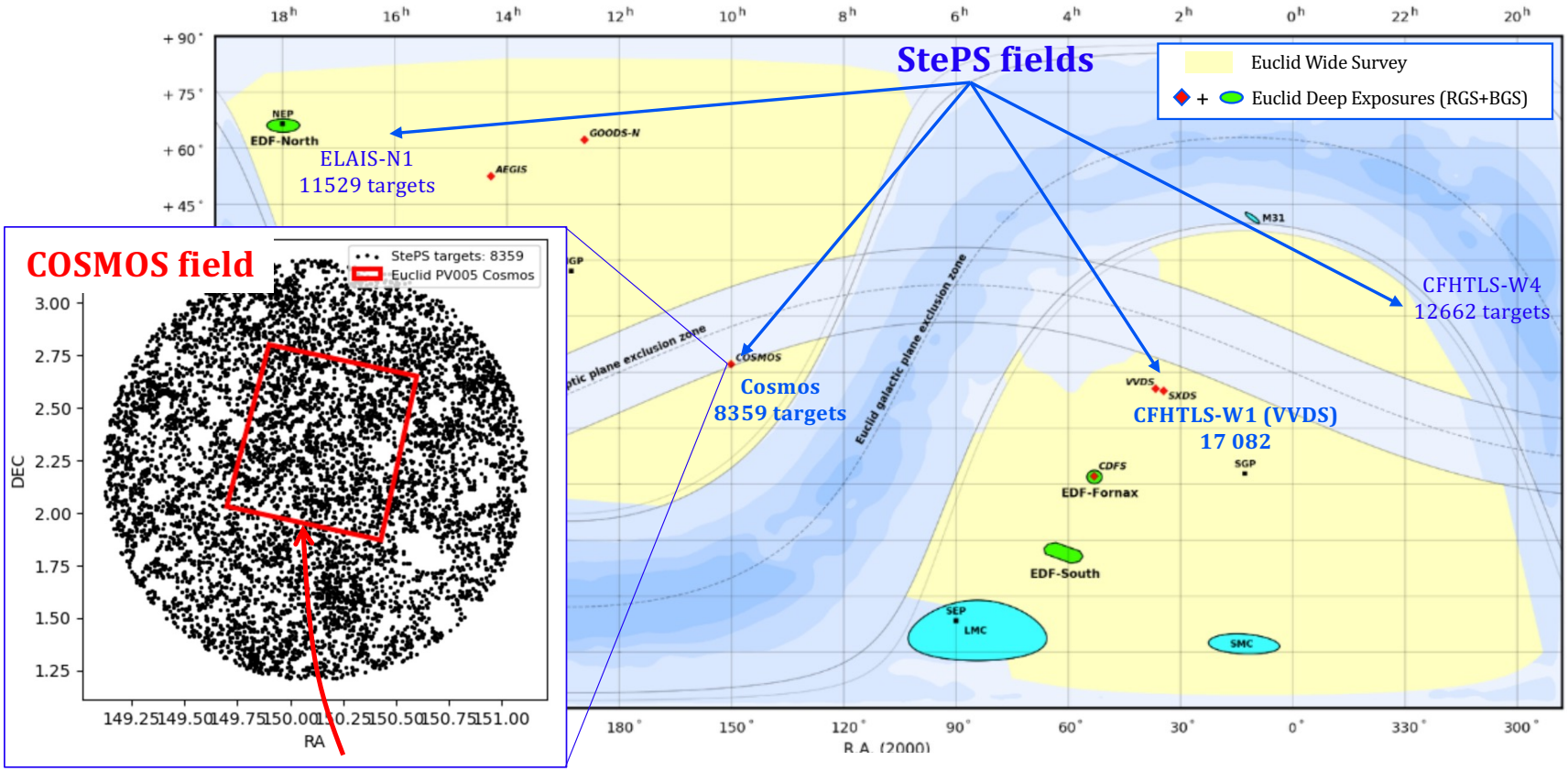
- **25k galaxies** located **at $z > 0.3$** over 25 deg^2 area
- Targets from HSC-SSP with $I_{AB} < 20.5$
- **> 7-hour exposure time!**
- Resolution ≈ 5000 & SNR = 10 $Å^{-1}$
- **60% of Star Forming Galaxies**

WEAVE/StePS will provide the best optical spectra to date!

Galactic surveys follow up to GAIA

Extra-Galactic surveys

Overlap between *Euclid* and WEAVE-StePS



COSMOS has already been observed by
Euclid with the **blue and red grism**

The WEAVE and *Euclid* spectrometers

WEAVE/WHT
Optical fibers
λ/Δλ ≈ 5000

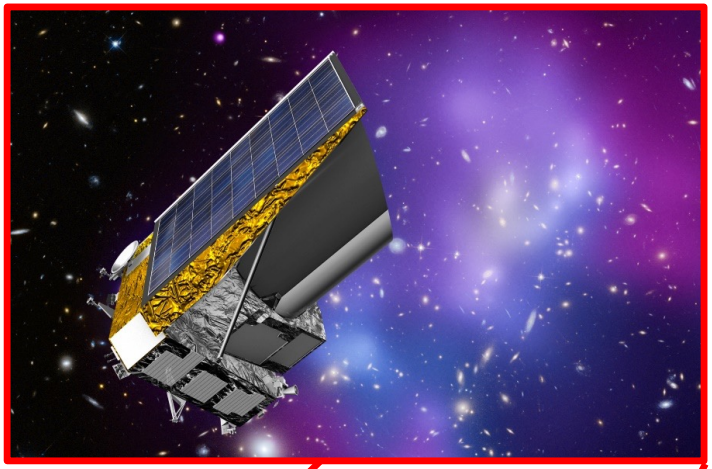
WEAVE
0.36 to 0.96 um

Let's take:

WEAVE-StePS star-forming targets at at *z* > 0.4

➔ **More than 2000 sources** in the **COSMOS field**

NISP-S/*Euclid*
Slitless
λ/Δλ ≥ 380



Blue grism
0.92–1.30 um

Red grism
1.25–1.86 um

Hβ emission line

Hα emission line

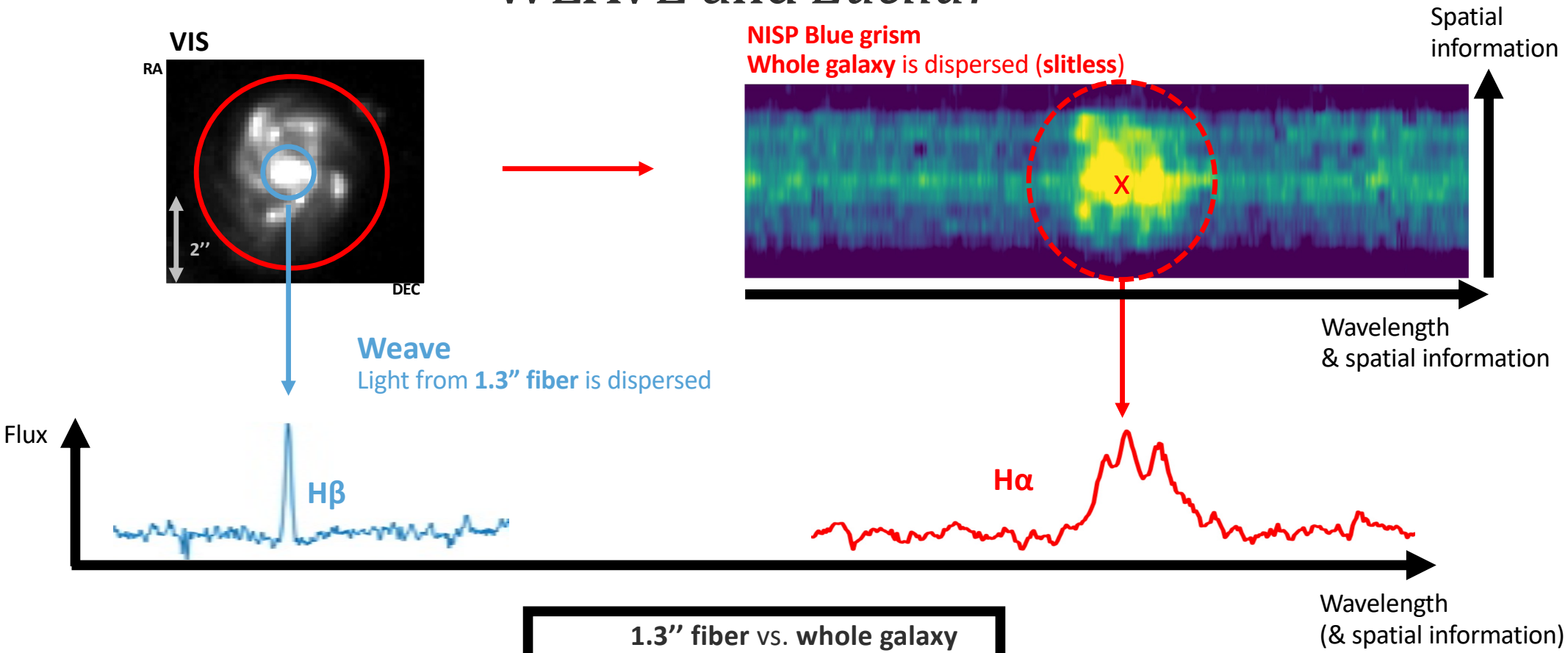
0.36 µm

1.86 um

Hα/Hβ ➔ **Dust attenuation study**

Euclid Preliminary

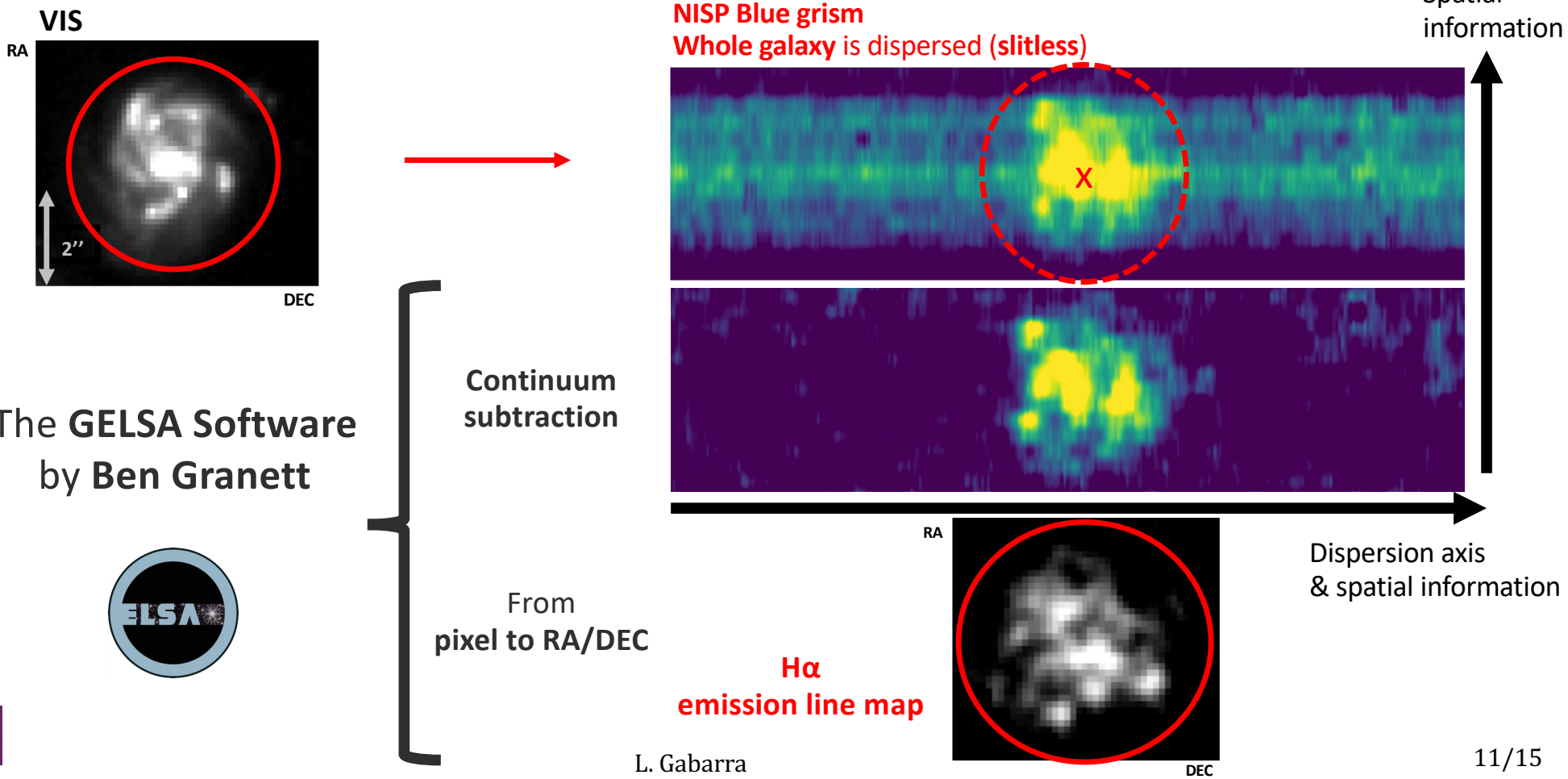
How to ensure consistent fluxes between WEAVE and *Euclid?*



1.3'' fiber vs. **whole galaxy**
➔Hα/Hβ unreliable

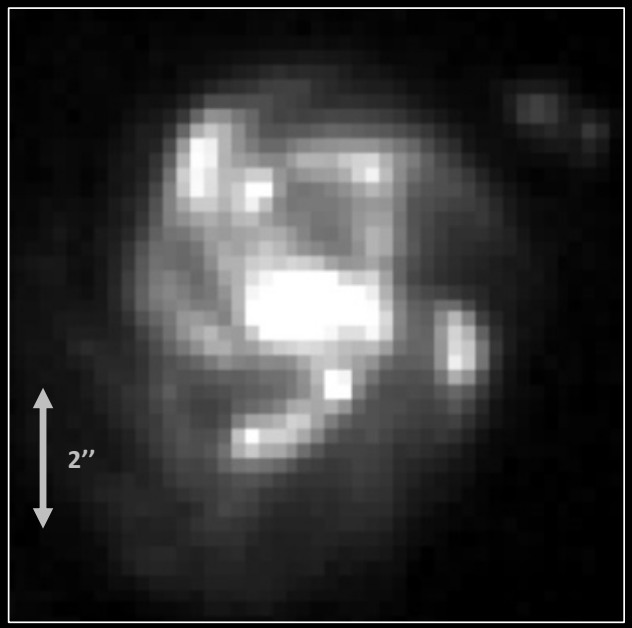
Euclid Preliminary

How to ensure consistent fluxes between WEAVE and *Euclid?*

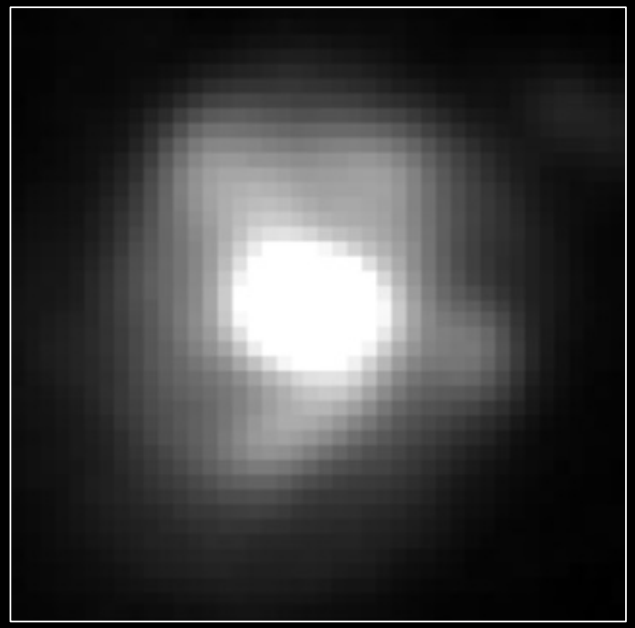


Euclid Preliminary

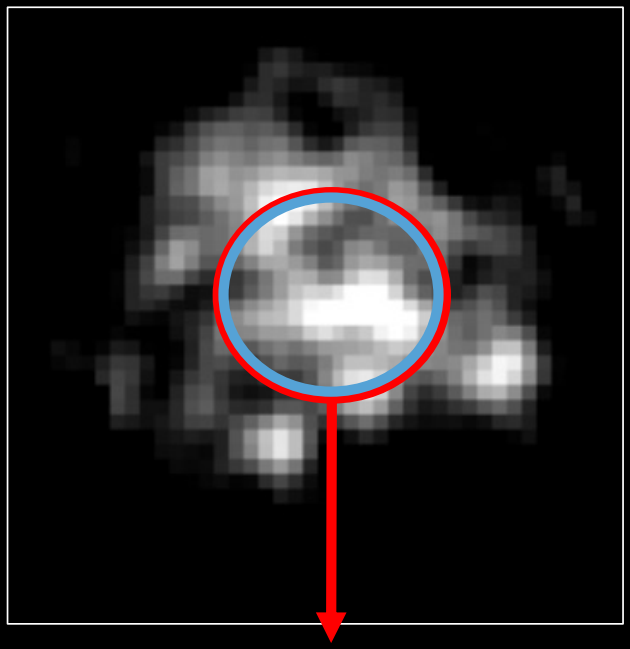
VIS



NISP Y

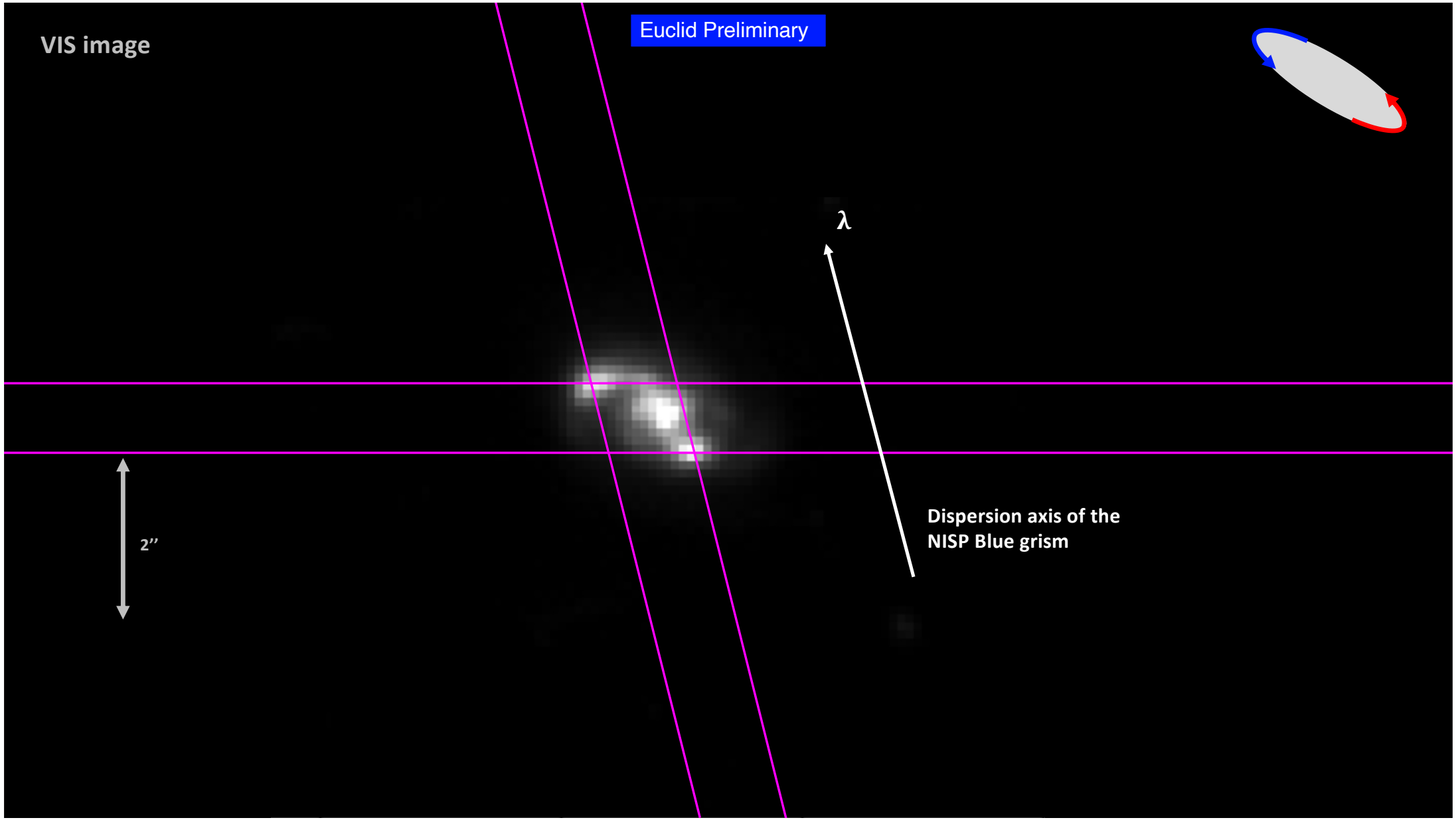


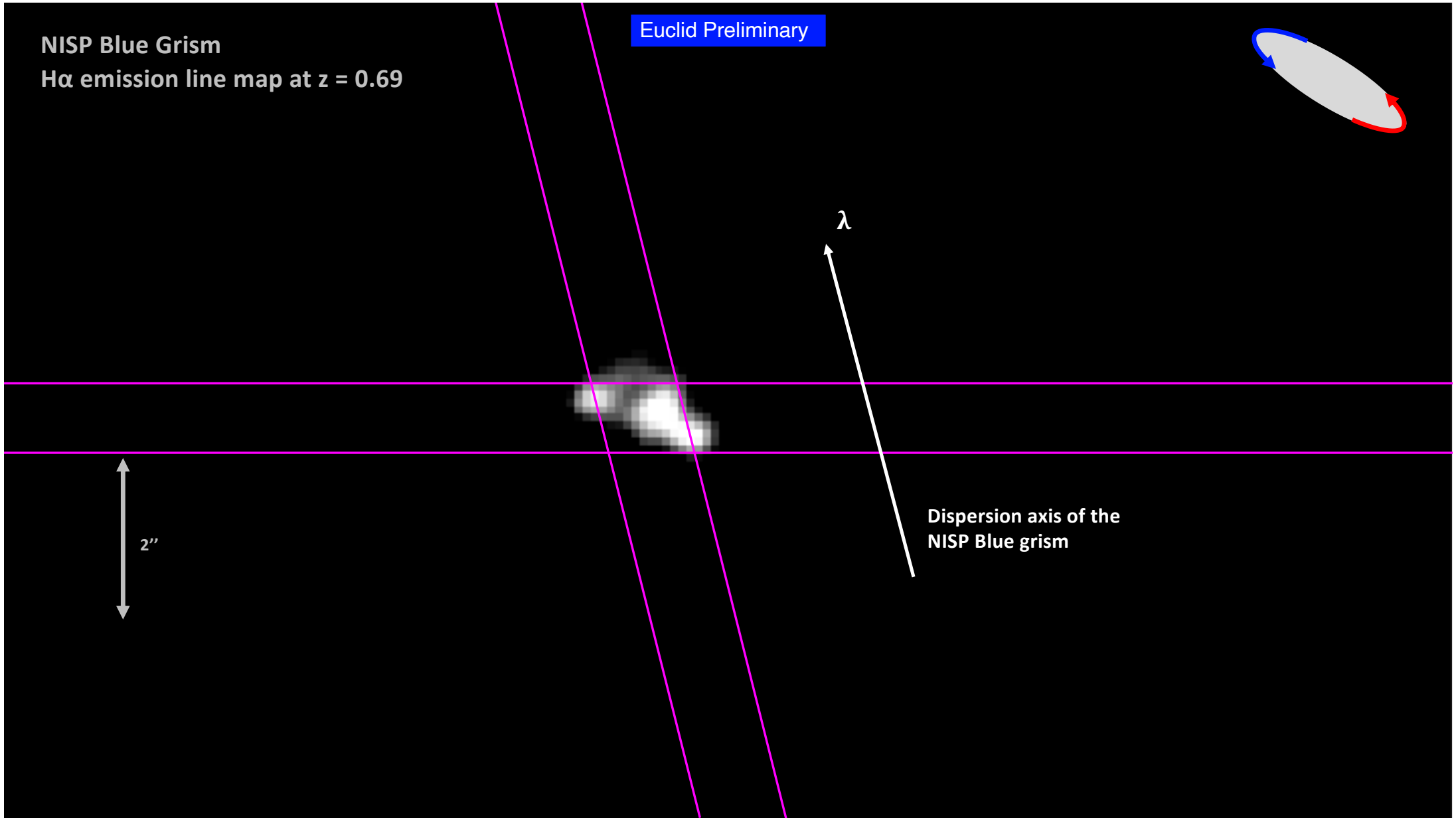
NISP blue grism
Hα emission line map



$z = 0.70$

Hα *(Euclid)* / Hβ (WEAVE)
Other aspects to consider:
PSF, Resolution, Flux calibration


VIS image
Euclid Preliminary
λ
Dispersion axis of the
NISP Blue grism
2''


NISP Blue Grism
Hα emission line map at z = 0.69
Euclid Preliminary
λ
2''
Dispersion axis of the
NISP Blue grism

Euclid Preliminary

Conclusions

- ***Euclid*-NISP + GELSA** → Great at producing **emission line maps!**
- **Great versatility** of the **NISP instrument** *(Gabarra, Granett et al. in prep 2025)*
- **>500k beautiful resolved emission line maps** expected during **the *Euclid* mission**
- Emission line maps can be used **for many science cases**
- **Synergy** between ***Euclid*** with ground & and **fiber based spectrograph** like **WEAVE** *(Dust attenuation study Gabarra et al. in prep 2026)*
- **WEAVE observations** (fibers + **mIFU (proposal in progress) ➔ cross-calib the EL maps**) → **Nov. 2025**