



Science & Technology Facilities Council
UK Astronomy Technology Centre

Stellar Populations with the E-ELT

Phase A Instrument Studies & UK Involvement

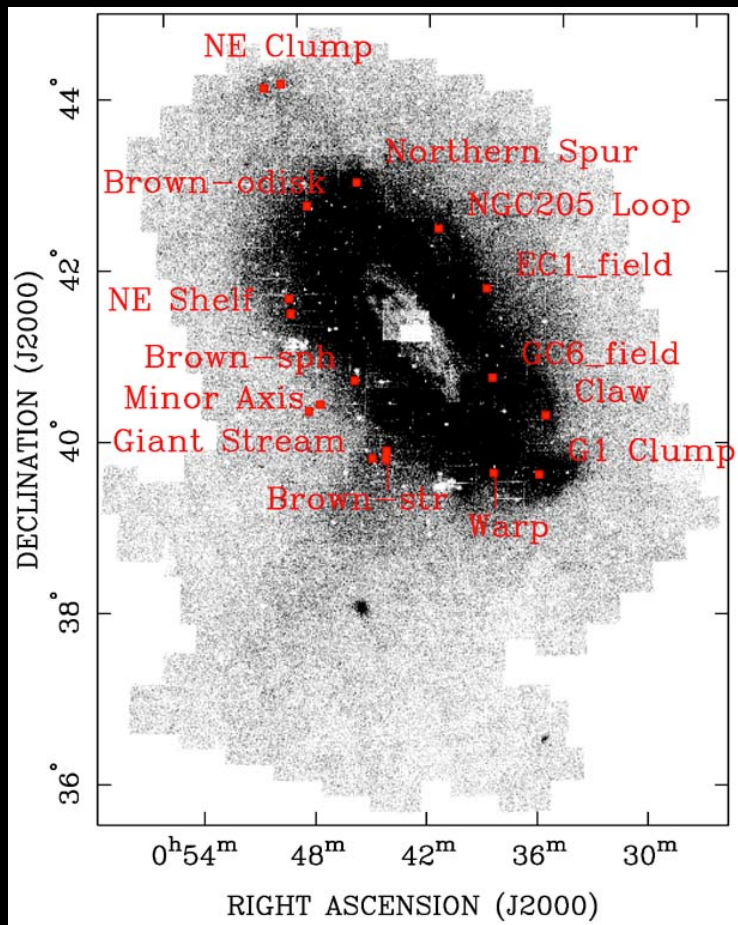
Chris Evans

Thanks to: Niranjan Thatte & Gavin Dalton

Cambridge, Sept 2009

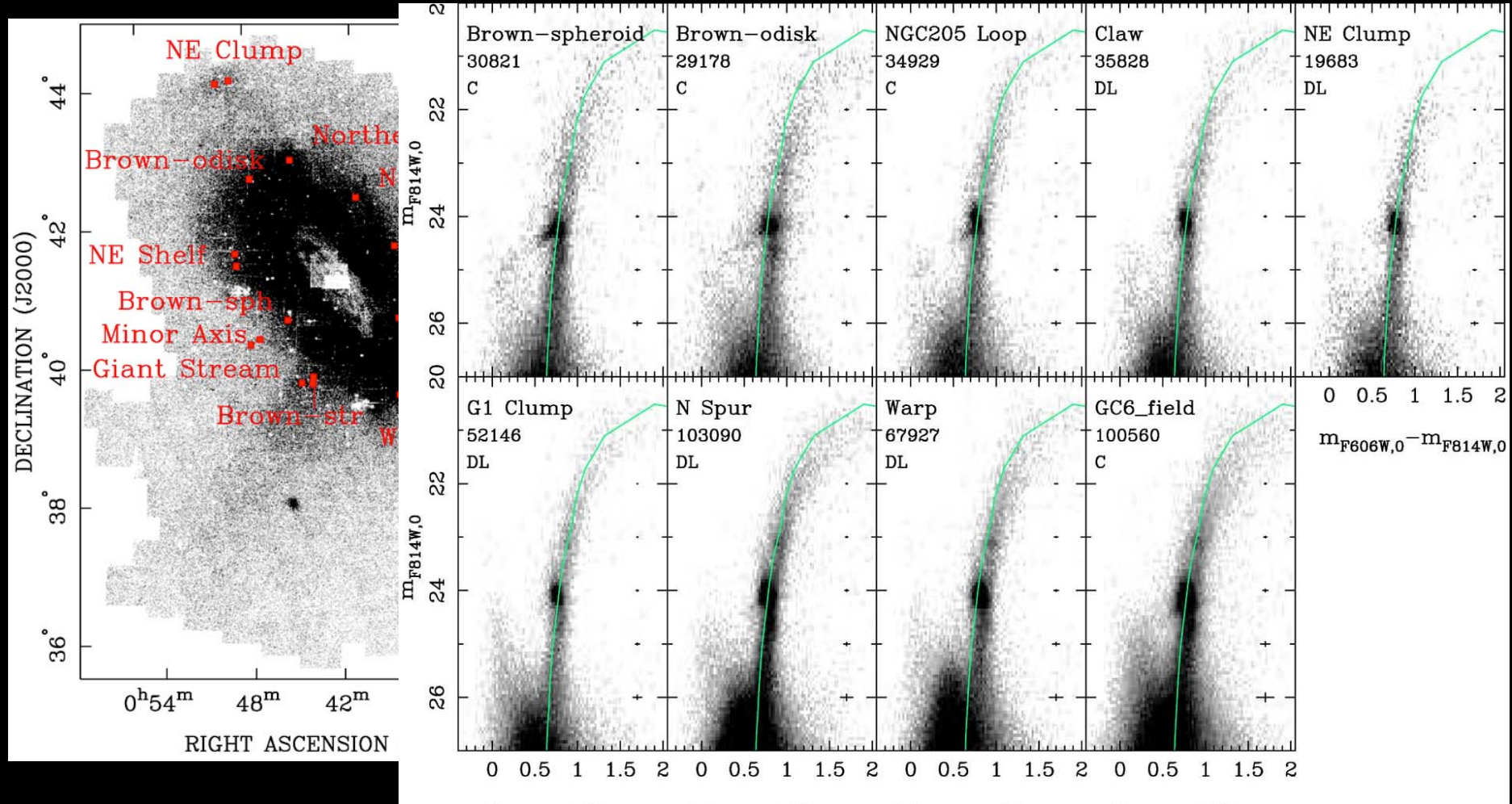
Resolved Stellar Populations in the Local Group

M31



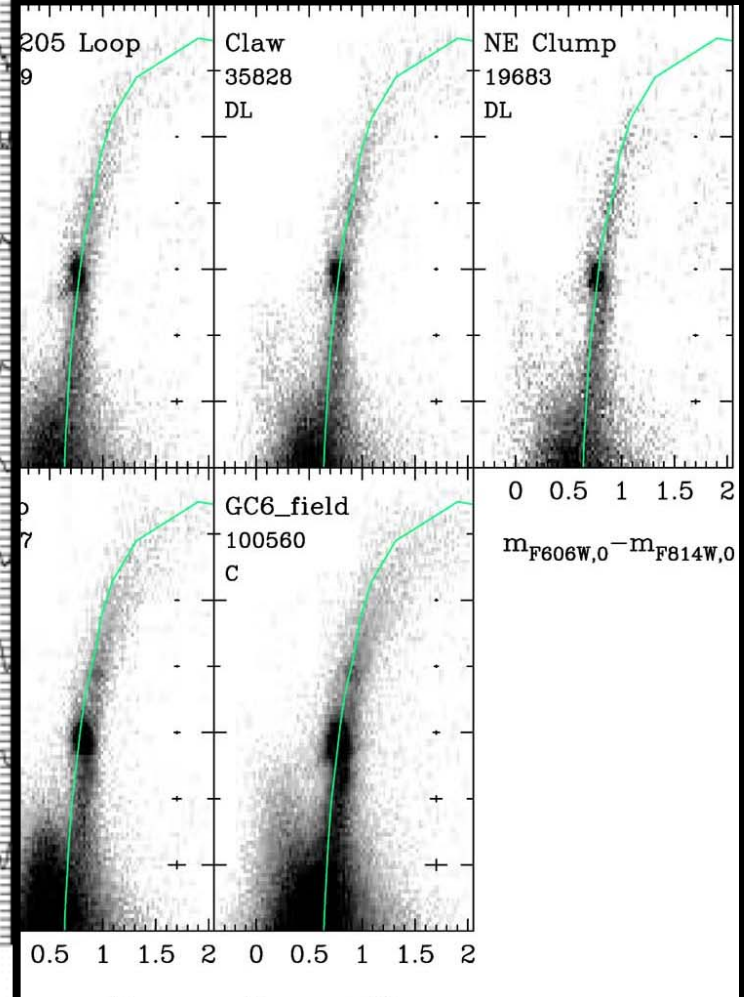
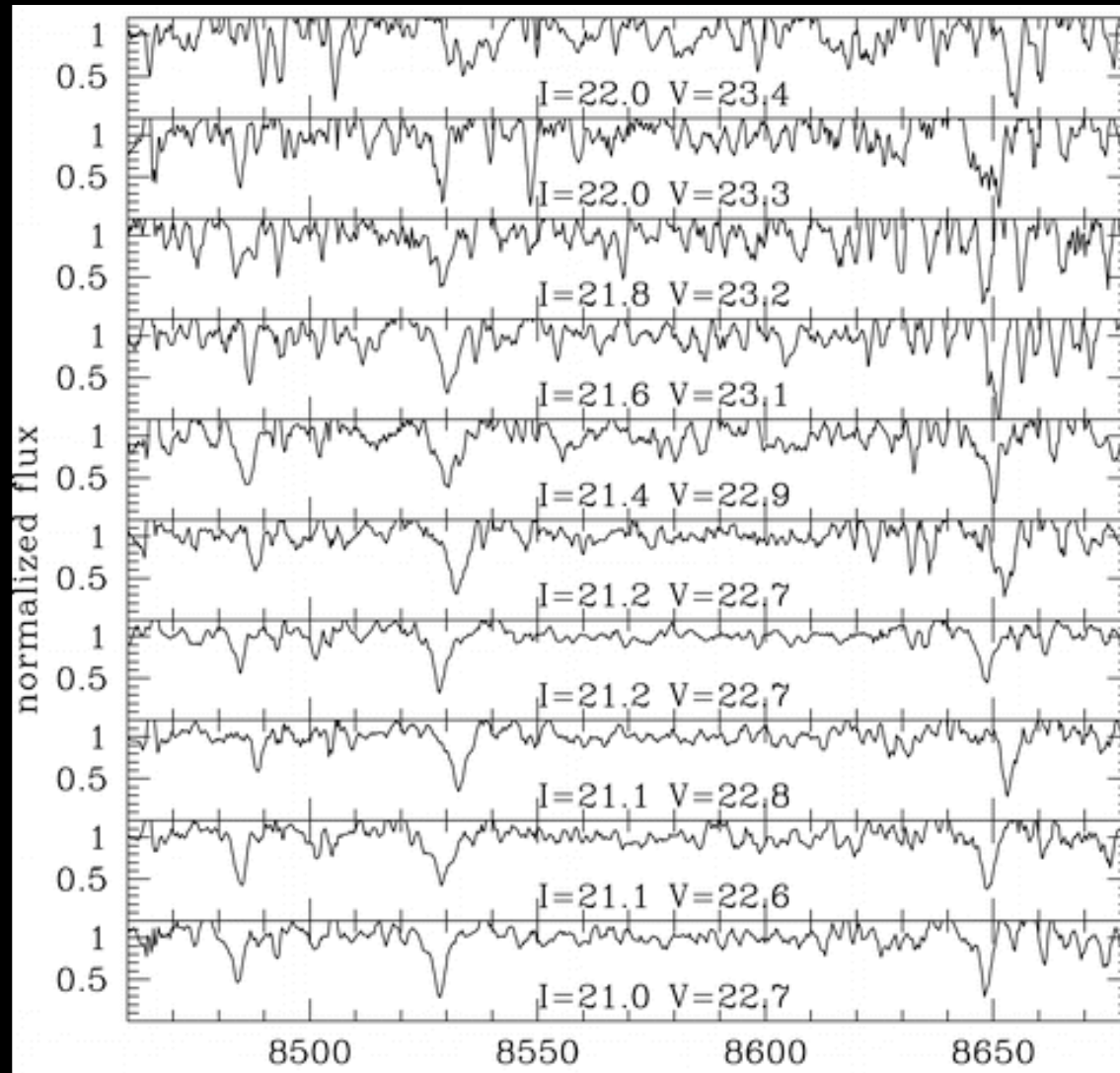
Resolved Stellar Populations in the Local Group

M31



Richardson et al. (2008)

Resolved Stellar Populations in the Local Group



KECK-DEIMOS in M31 Chapman et al. (2006)

Richardson et al. (2008)

The ELT era

Resolved Stellar Populations in the Local Volume

ELTs will unlock a huge range of new targets, including:

- NGC 3109 & Sextans A (1.3 Mpc)
- Spiral-dominated Sculptor Group (2-4 Mpc)
- M83/NGC5128 grouping (4-5 Mpc)
- NGC3379 (11 Mpc)
- Virgo Cluster galaxies (16-17 Mpc)



The (near) Local Volume

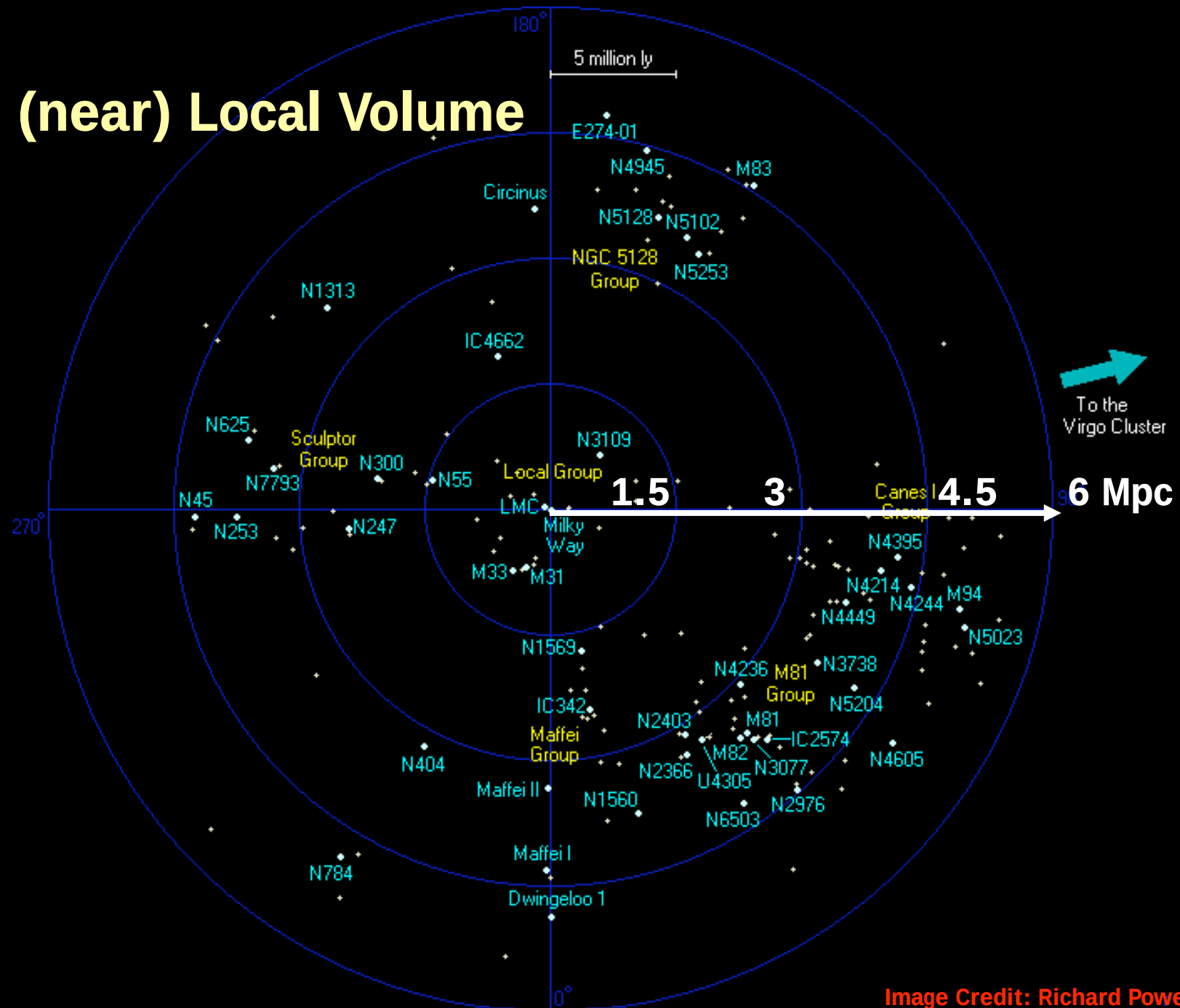
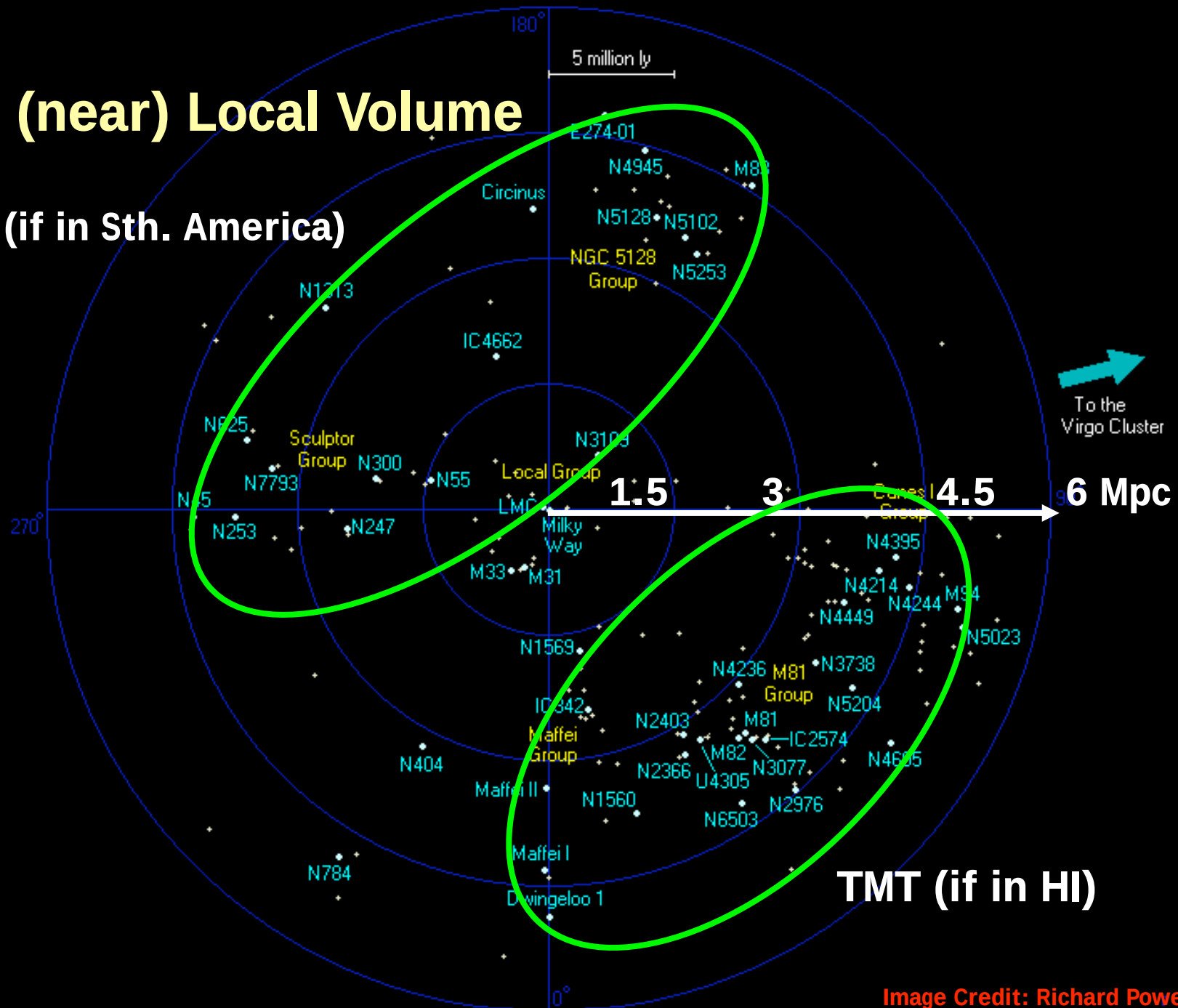


Image Credit: Richard Powell

The (near) Local Volume

E-ELT (if in Sth. America)



E-ELT Phase A Instrumentation Studies

EAGLE	Multi-IFU, near-IR spectrometer
HARMONI	Diffraction-limited, near-IR & optical IFU
OPTIMOS	Seeing-limited/GLAO high-multiplex spectrograph
EPICS	XAO imager/spectro-polarimeter for exo-planets
METIS	Mid-IR (5-30 μ m) imager & spectrometer

UK Partners

CODEX Ultra-high-resolution optical spectrograph
Science lead: Martin Haehnelt (Cambridge)

MICADO Near-IR, high-resolution imaging camera

~~**SIMPLE** Near-IR, high-resolution spectrograph~~

AO-relays MAORY (MCAO relay) & ATLAS (LTAO relay)

MICADO

- Multi-AO Imaging Camera for Deep Observations
- PI: Reinhard Genzel, MPE
- JHK imager

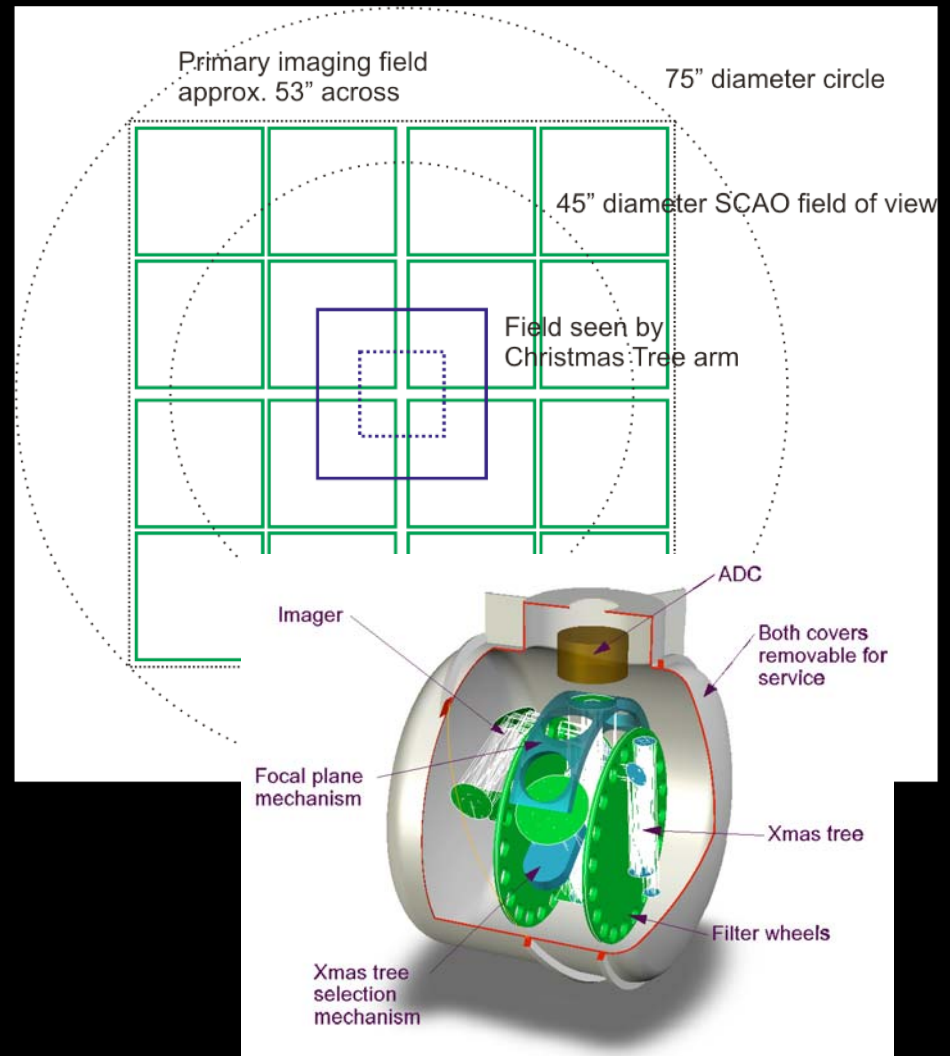
Primary Imaging Field

- 53" across, 3mas pixels
- high throughput
- 4x4 HAWAII 4RG detectors
- ~20 filter slots

Xmas Tree Arm

- 1.5mas & 4mas pixels
- imaging & spectroscopy

Davies et al. arXiv: 0909.2100

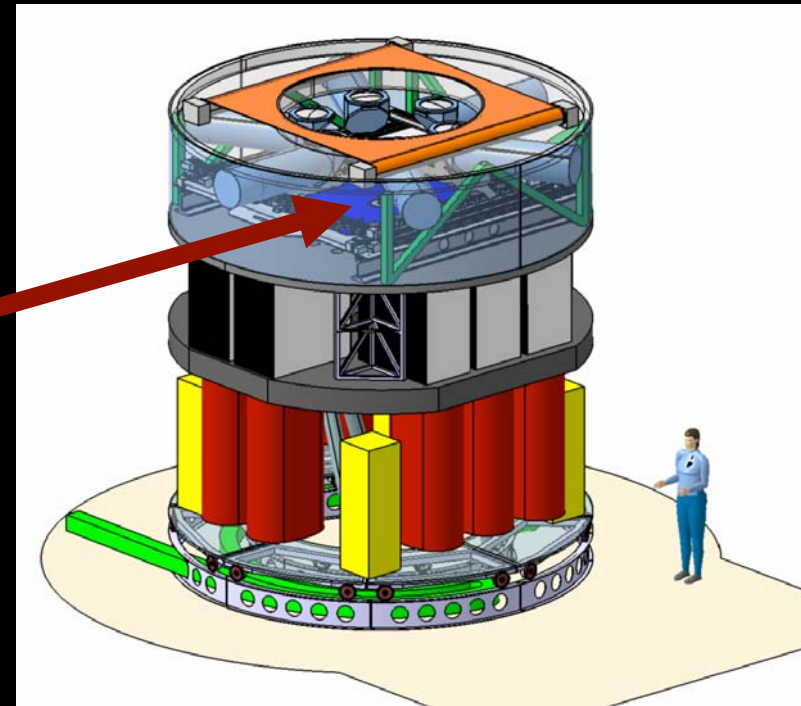
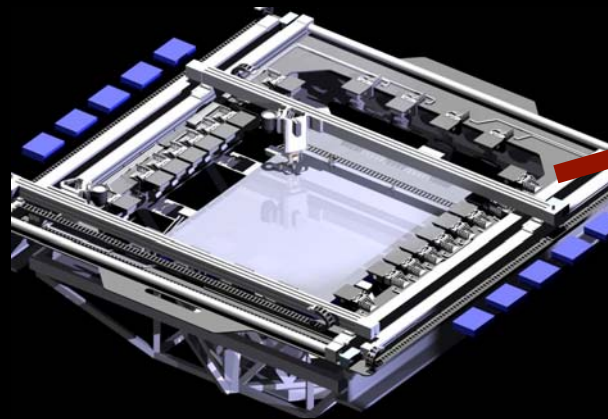




EAGLE

- Multi-IFU, AO-corrected, near-IR spectrograph
- PI: Jean-Gabriel Cuby (Marseille)
- End of Phase A: Sept 2009

Evans et al. arXiv: 0909.1748





EAGLE Baseline Design

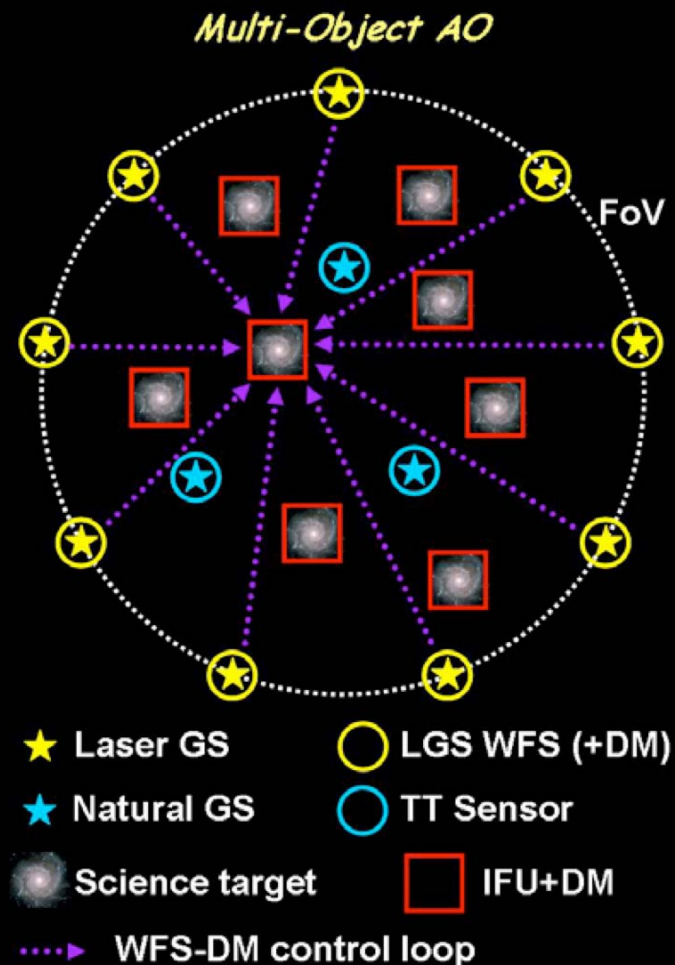
- Mounted at gravity-invariant Nasmyth focus

Parameter	Specification
Patrol Field	eqv. 7 arcmin diameter
Science subfield (IFU FOV)	1.65 x 1.65 arcsec
Multiplex	20
Spatial Resolution	30% EE in 75mas (H-band)
Spectral resolving power	4,000 & 10,000
Wavelength range	0.8-2.5 μm



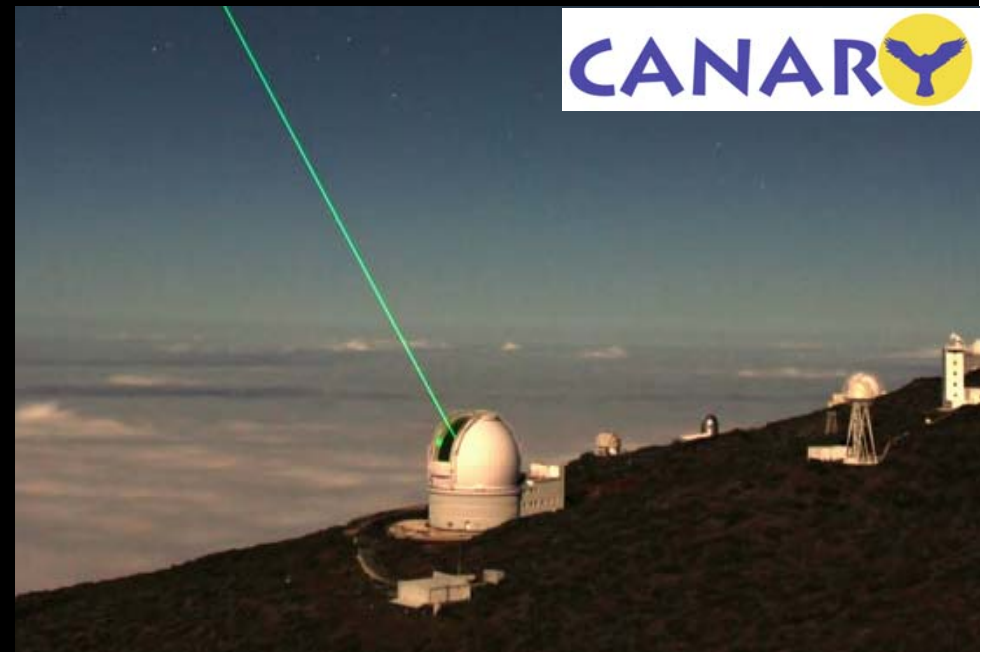
EAGLE AO

Multi-Object Adaptive Optics (MOAO)



CANARY: 2010-2012:

- Demonstrate MOAO in EAGLE config.
- Improve real-time control techniques
- Develop calibration techniques





EAGLE Point-source Performance

- Seeing = 0.65", $t_{\text{exp}} = 20 \times 1800\text{s}$, $R = 10,000$
- Two NGS configurations

CaT (I band)

I_{VEGA}	S/N [PSF1]	S/N [PSF2]
22.5	56	48
23.5	28	24
24.5	13	10

4 mags deeper than
FLAMES LR08 observations

CO bandhead (K band)

K_{VEGA}	S/N [PSF1]	S/N [PSF2]
22.5	53	42
23.5	23	20
24.5	11	10

Can also operate with just
telescope GLAO

HARMONI

- Near-IR & visible integral-field spectrograph
- PI: Niranjan Thatte (Oxford)
- End of Phase A: December 2009

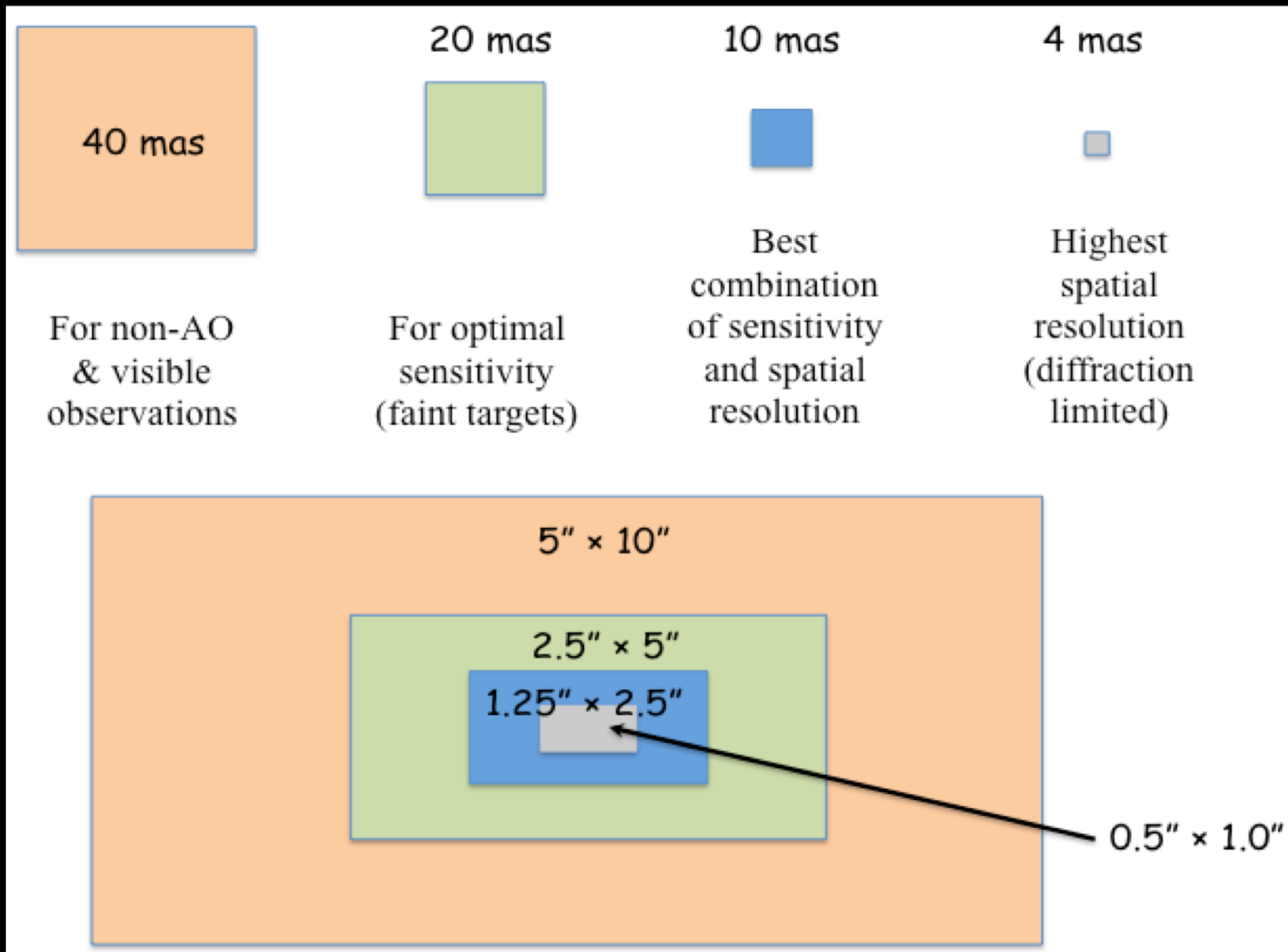


HARMONI Specs

- Nasmyth focus, behind ATLAS LTAO module
 - Can also run in other AO modes: noAO/GLAO, SCAO

Parameter	Specification
Field-of-view	Up to 5 x 10 arcsec
Spatial Resolution	Four scales: 4, 10, 20 & 40 mas/spaxel
Spectral resolving power	4,000, 10,000 & 20,000
Wavelength range	Optical (2 spectrographs): 0.5-0.82 μm Near-IR (8 spectrographs): 0.82-2.4 μm

HARMONI Spatial Sampling

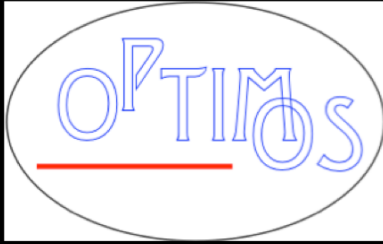


HARMONI Point-source Performance

- Seeing = 0.8", $t_{\text{exp}} = 5$ hrs, S/N = 5, LTAO
- R and H bands as representative of optical/near-IR
(FWHM ~ 200 & 8 mas, respectively)

	4 mas		20 mas	
Spectral Resolution	R_{AB}	H_{AB}	R_{AB}	H_{AB}
4,000	24.2	27.1	25.1	27.3
10,000	23.2	26.4	24.4	26.8
20,000	22.5	25.7	23.7	26.4

In modest conditions (or without AO) can still exploit the E-ELT for factor of 25 in speed in the red optical cf. VLT-MUSE



OPTIMOS-EVE



- Two parallel studies for a large multiplex MOS
- OPTIMOS-EVE: Francois Hammer & Gavin Dalton
- OPTIMOS-DIORAMAS: Olivier Le Fevre
- End of Phase A: Feb 2010



OPTIMOS Specs



Parameter	Specification
Patrol Field	7 arcmin
Multiplex	300 point sources
Deployable IFUs	Up to 6 x 12 arcsec
Spatial Resolution	Seeing-limited/GLAO
Spectral resolving power	5,000 & 40,000
Wavelength range	Optical (B) thru' to H

Stellar Populations with the E-ELT

- A range of capabilities for stellar pops. programmes:

VLT analogy



ELT

FLAMES (+JH bands)

OPTIMOS-EVE

KMOS (+AO)

EAGLE

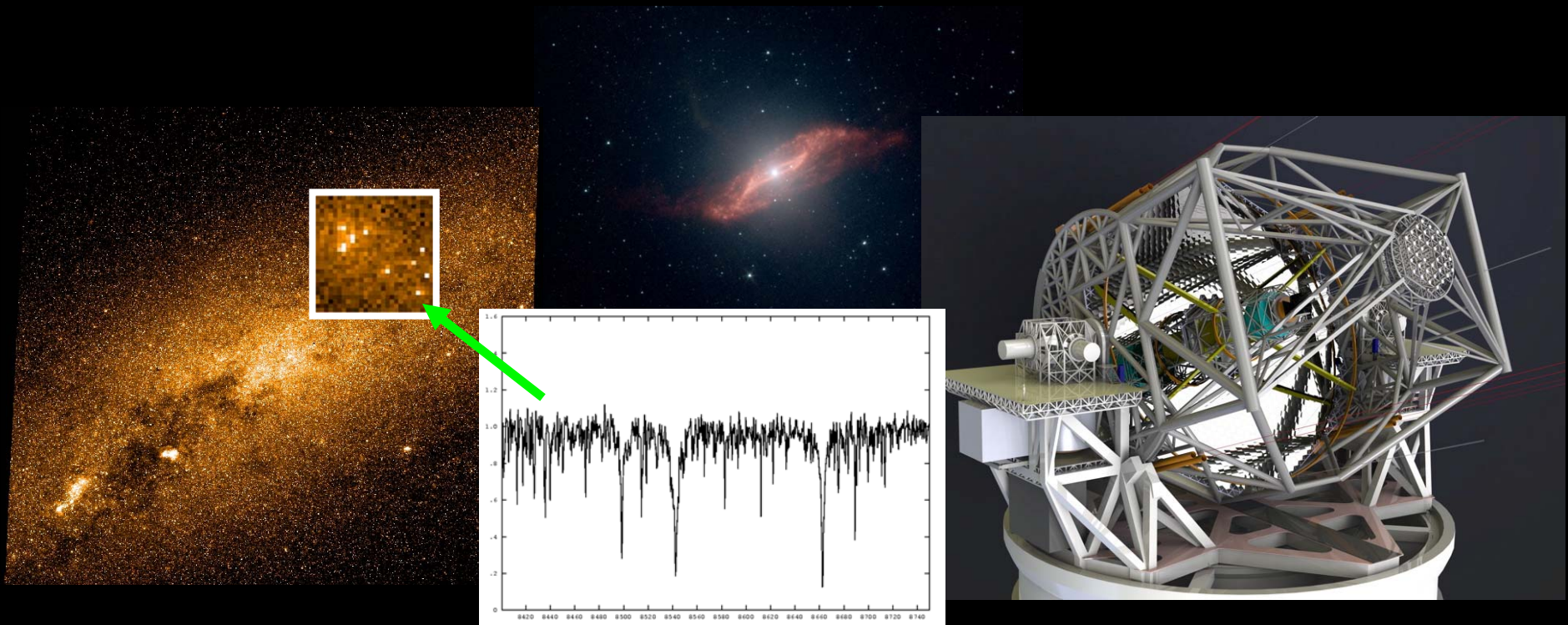
SINFONI (+vis.)

HARMONI

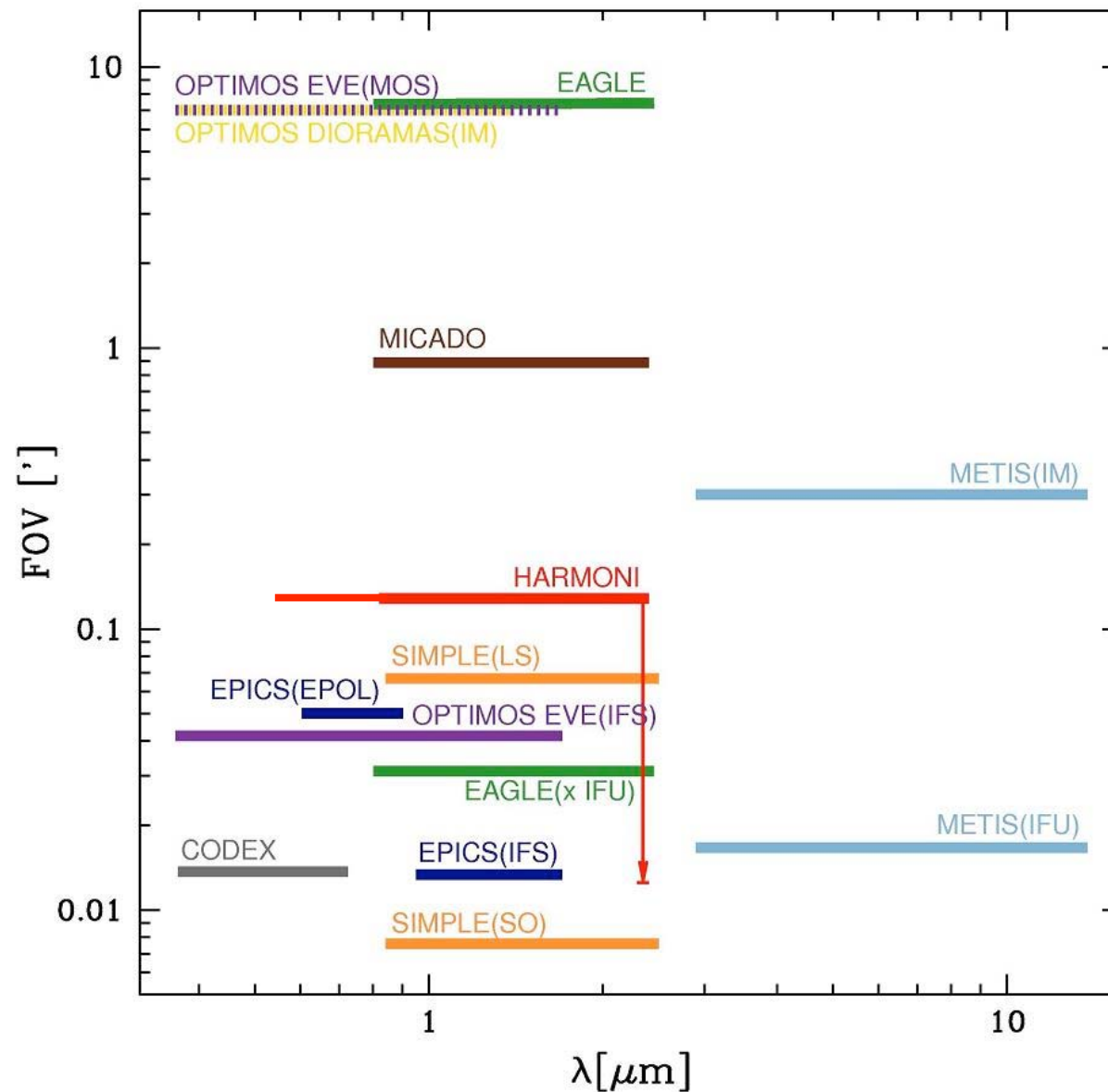


Summary

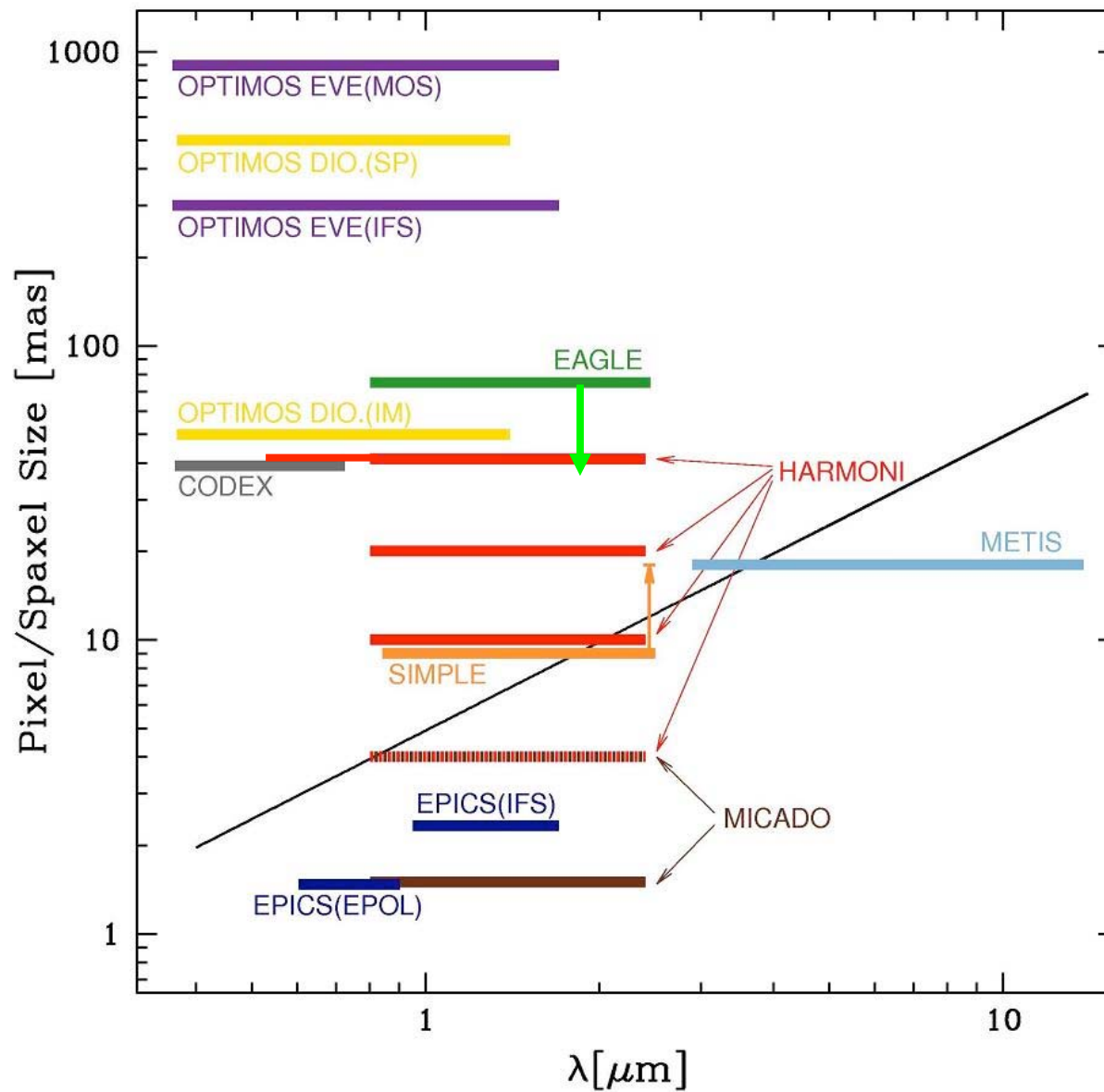
- First generation suite to be decided in the coming year
- Huge potential for spectroscopy of stellar populations!



Phase A Studies: Field-of-view



Phase A Studies: Spatial Sampling



Phase A Studies: Spectral Resolution

