Calar Alto Spectroscopic Explorer (CASE)

Large Spectroscopic Facility at CAHA

LoI for new instruments at Calar Alto 3.5m (11th June 2018)
IAA (CSIC) + LAM-CNRS (France) + CfAI (Durham Univ.) + AAO (Australia)

LoI is approved and feasibility study funded with 100k euro

In the room: Gilles Bergond, Johan Comparat, Helene Courtois, Graham Murray, Enrique Pérez, Francisco Prada, Justo Sánchez

LAM, Sept. 20th, 2018

Large-IFU Spectroscopic Facility at CAHA

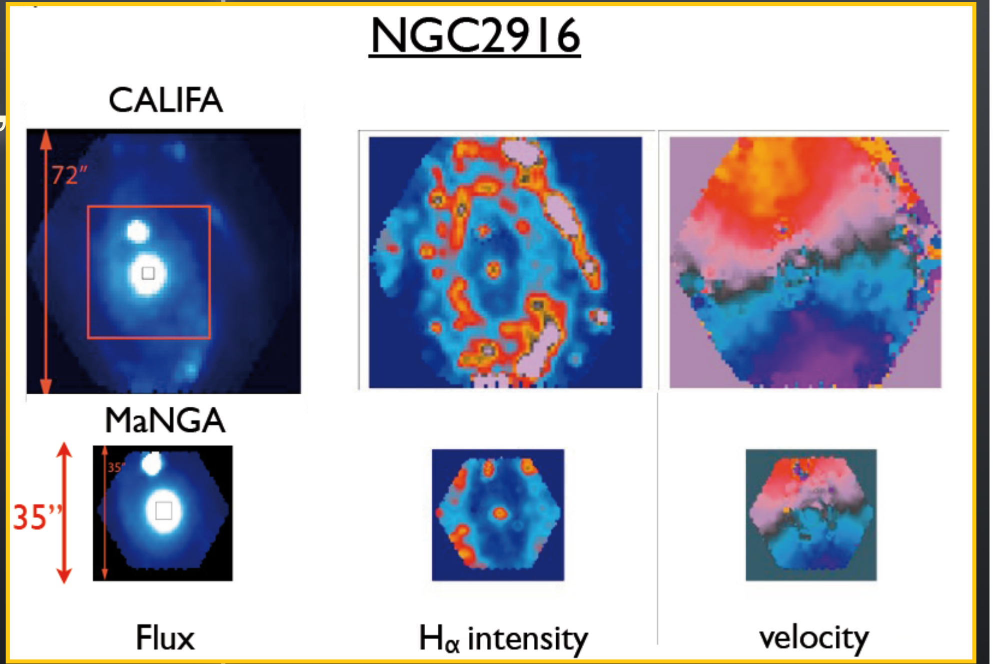
Schmidt 80cm

3.5 m

Niche for a Large-IFS at 3.5m CAHA

IFU characteristics

- PPaK@CAHA: 1.2 arcmin x 1 arcmin,
  - R ~ 500 : 3700 —7000 A
  - 2.6 arcsec/spaxel
- MUSE@VLT: 1.2 arcmin x 1 arcmin,
  - R ~2000: 4650 — 9300 A
  - 0.2 arcsec/spaxel
- MaNGA: diameter ~12 to 32 arcsec
  - R ~2000: 3600 — 10000 A
  - 2 arcsec/spaxel
- LIFU(WEAVE)@WHT: 1.5 x 1.3 arcmin
  - LR 2500: 3360 — 9840 A
  - 2.6 arcsec/spaxel

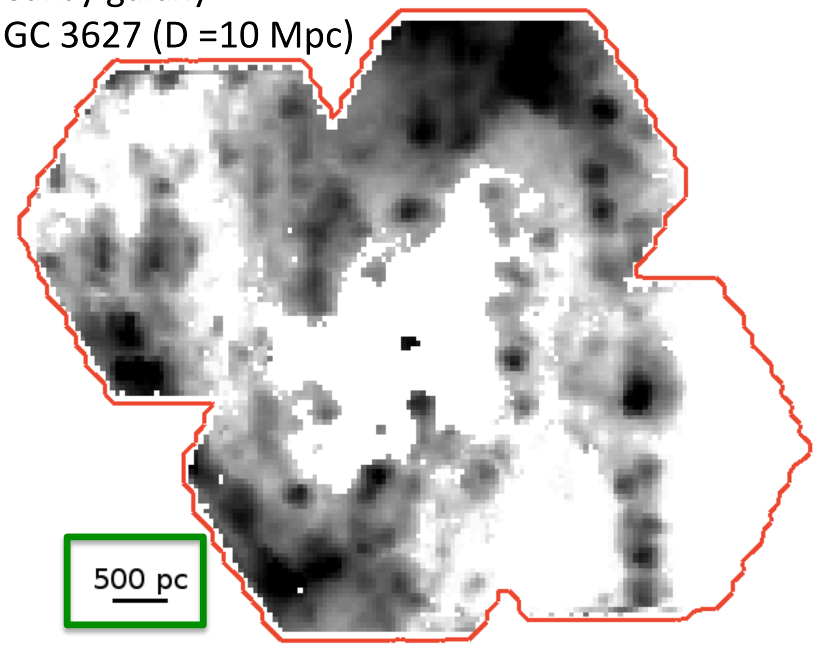


Kathryn Kreckel (MPIA)

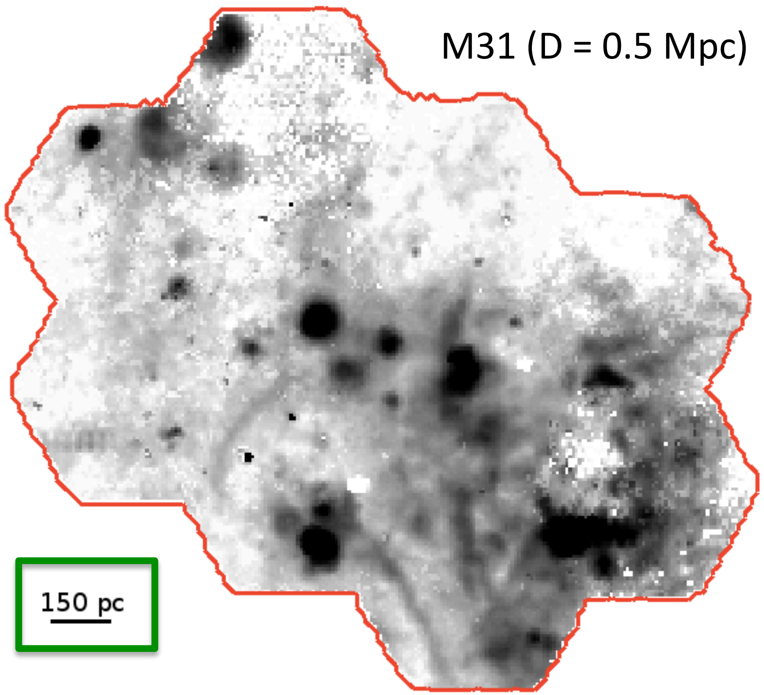
Optical IFU maps of nearby galaxies enable us to

- resolve HII regions
- reveal & resolve the diffuse ionized gas
- map dust within galaxies

Nearby galaxy
NGC 3627 (D =10 Mpc)

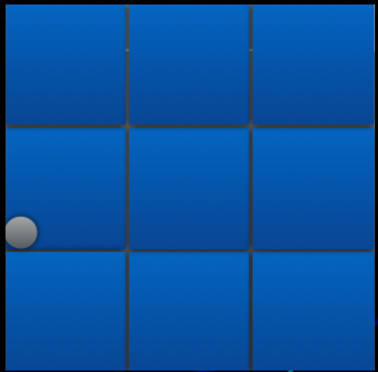


M31 (D = 0.5 Mpc)



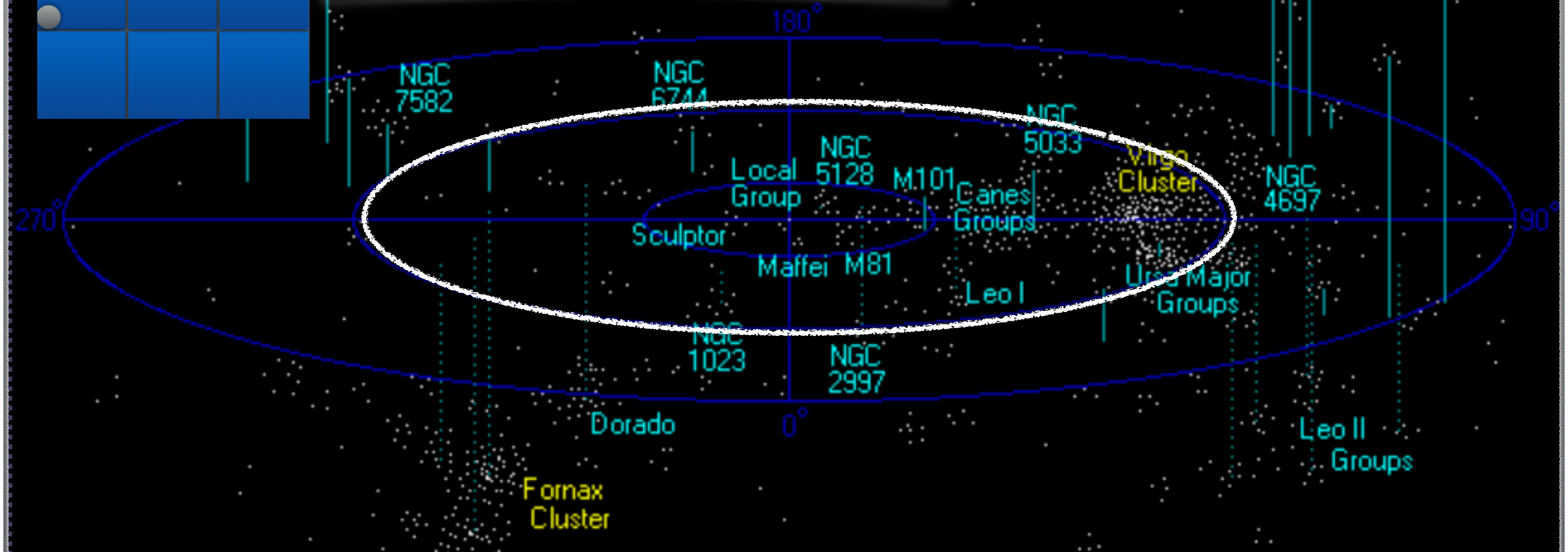
Observed using PMAS/PPAK at Calar Alto

Local Universe: sphere of 15 Mpc center at the local group
Local Volumen distribution of galaxies (~10 Mpc) + Virgo cluster

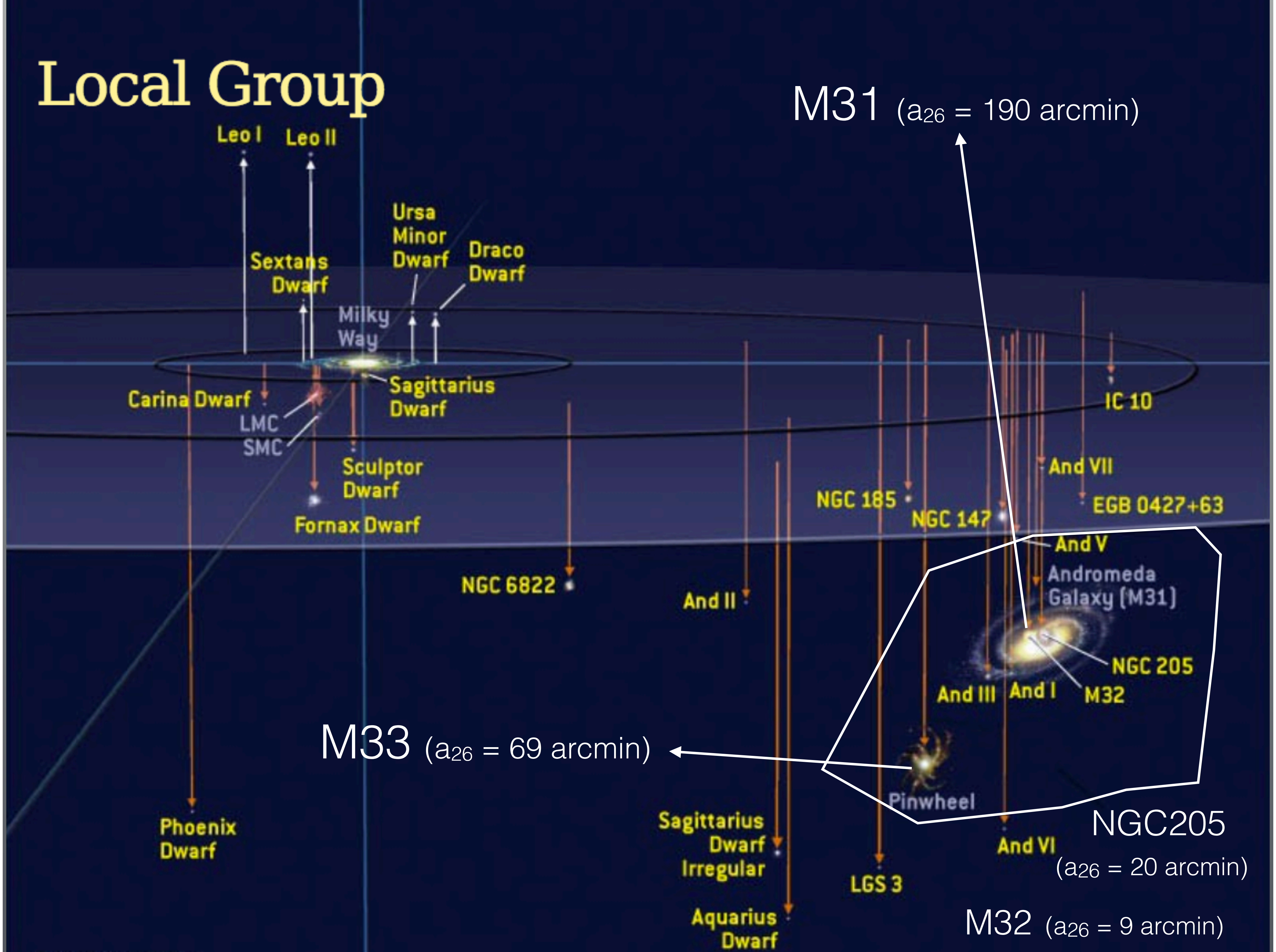


Large-IFU

- FoV: 3 arcmin x 3 arcmin



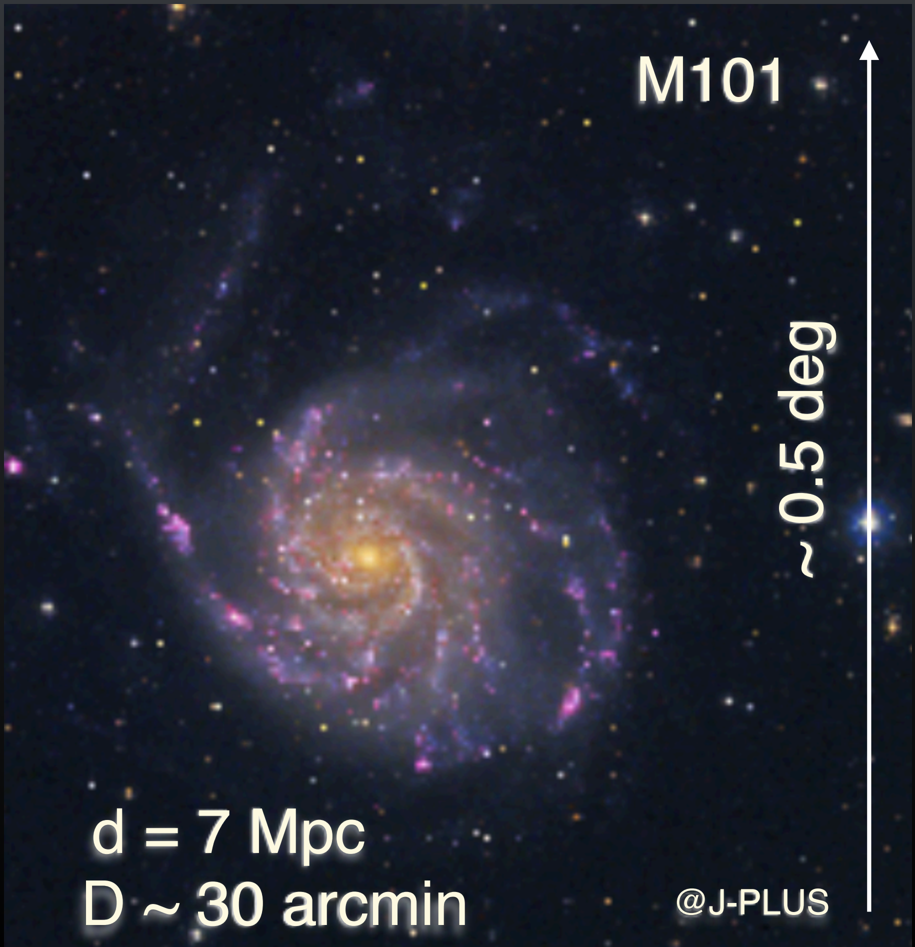
scale < 80 pc/arcsec
Constrains to the sub grid physics for simulations of galaxy formation



Local Group
M31 (a26 = 190 arcmin)
Leo I
Leo II
Ursa Minor Dwarf
Draco Dwarf
Sextans Dwarf
Milky Way
Carina Dwarf
LMC
SMC
Sagittarius Dwarf
Sculptor Dwarf
Fornax Dwarf
IC 10
And VII
EGB 0427+63
NGC 185
NGC 147
And V
NGC 6822
And II
Andromeda Galaxy (M31)
NGC 205
M32
And III
And I
M33 (a26 = 69 arcmin)
Pinwheel
Phoenix Dwarf
Sagittarius Dwarf Irregular
LGS 3
And VI
NGC205 (a26 = 20 arcmin)
Aquarius Dwarf
M32 (a26 = 9 arcmin)

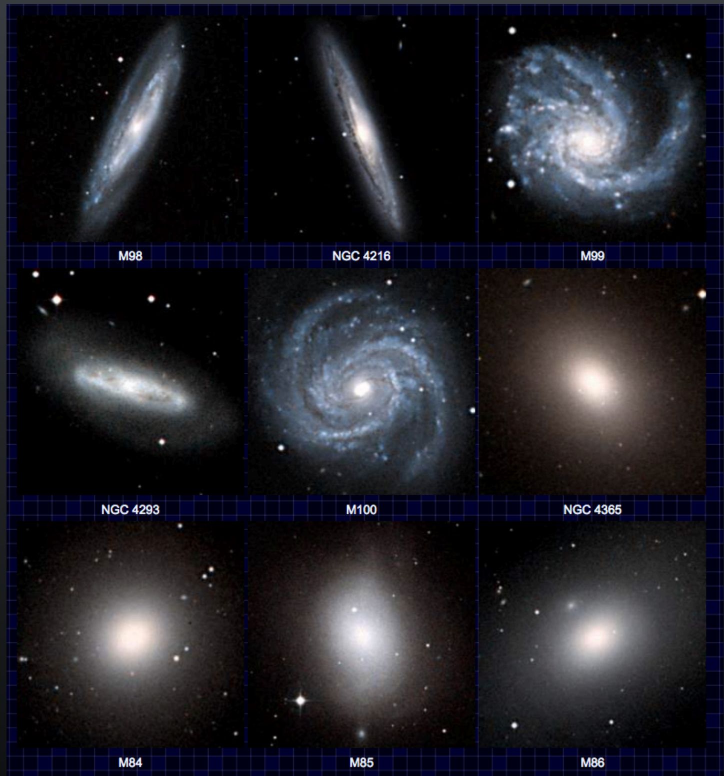
Local Universe: Niche for a Large-IFU at 3.5m CAHA

IAU: Local Universe: sphere of 15 Mpc
center at the local group
Local Volume distribution of galaxies
(d< 11 Mpc) + Virgo cluster



Galaxies of Local Universe
1 arcmin < D < 30 arcmin

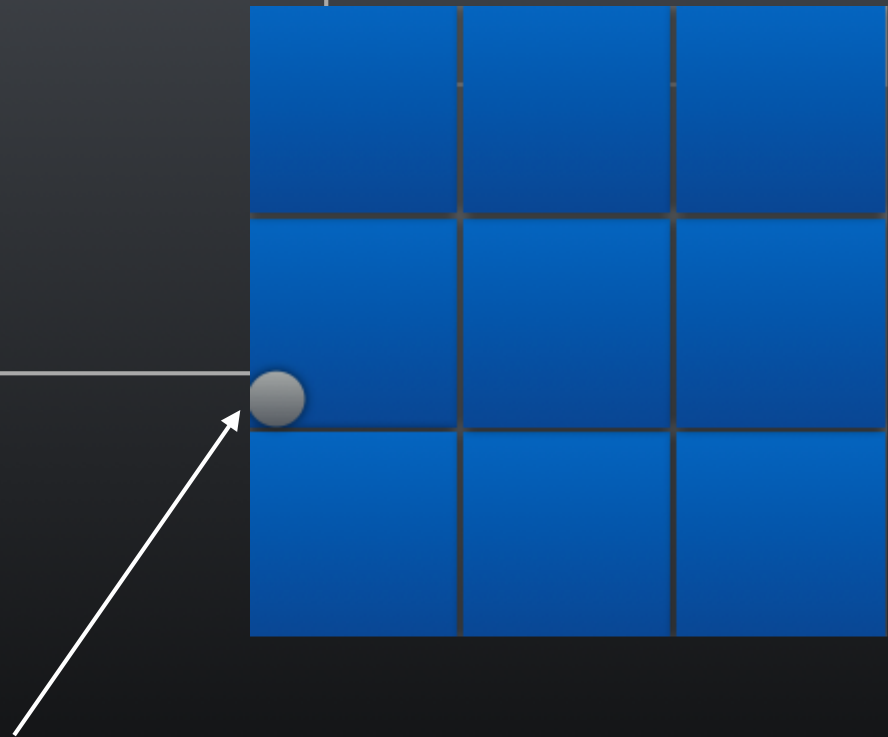
Galaxies in Virgo



- M86 (E3): 10 arcmin
- M84 (E1): 6 arcmin
- NGC4435 (S0): 3 arcmin
- NGC4438 (Sa): 9 arcmin
- M100 (Sbc): 7 arcmin

IFU6000 at the 3.5m telescope

- Local Volume Sample (d < 11 Mpc) + Virgo Cluster
- Ngal ~ 300-500 galx
- 3600 to 7000 A
- R ~2000
- FoV ~3x3 arcmin (continuous)
- fiber size ~2.5 arcsec
- mean distance 7 Mpc (LV): 85 pc
- Virgo: 190 pc

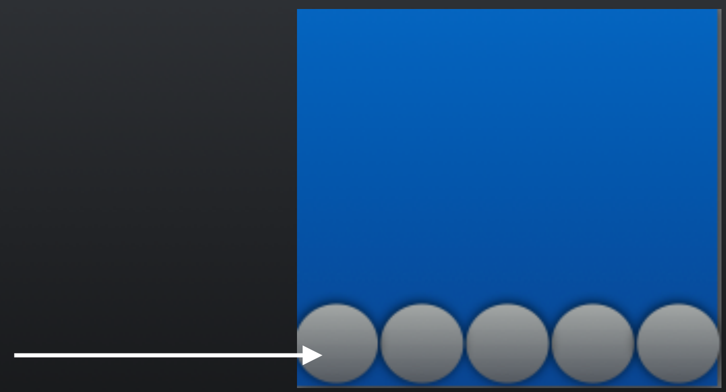


9 cloned spectrographs
FoV = 3x3 arcmin
600 fibers of 2.5 arcsec

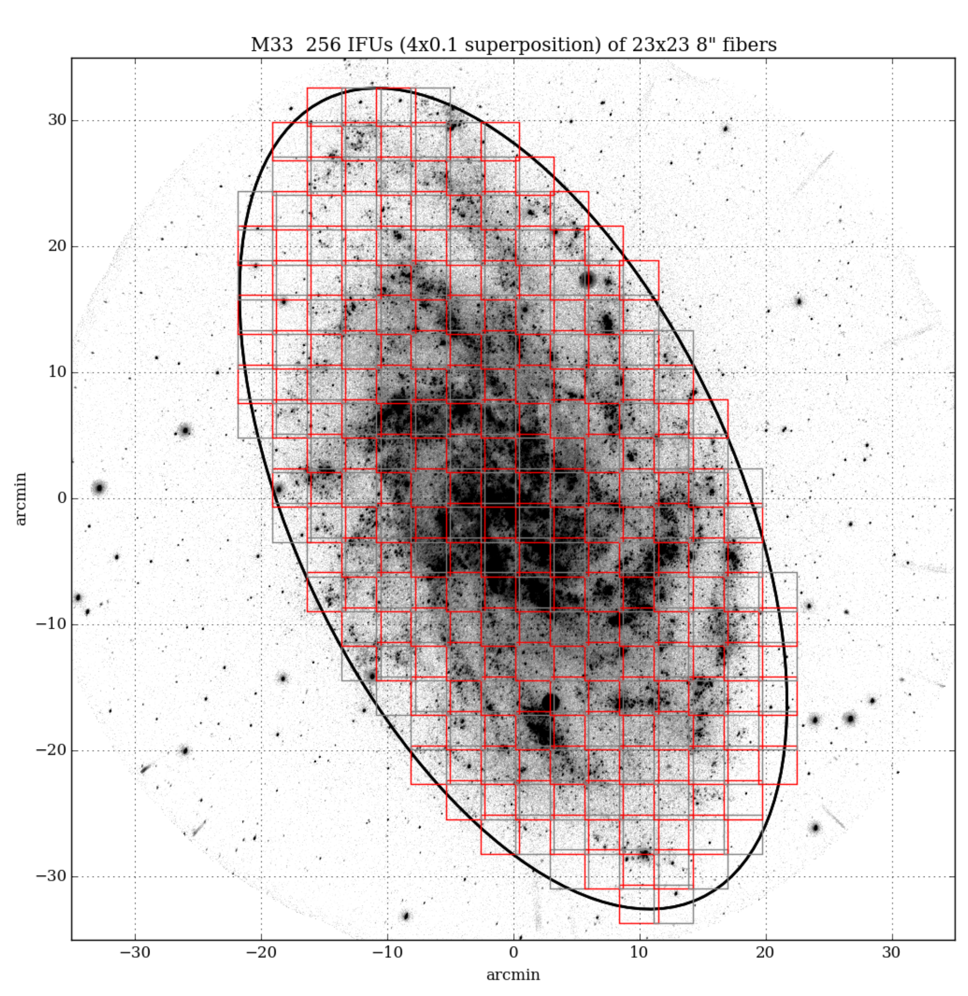
IFU600 at the Schmidt

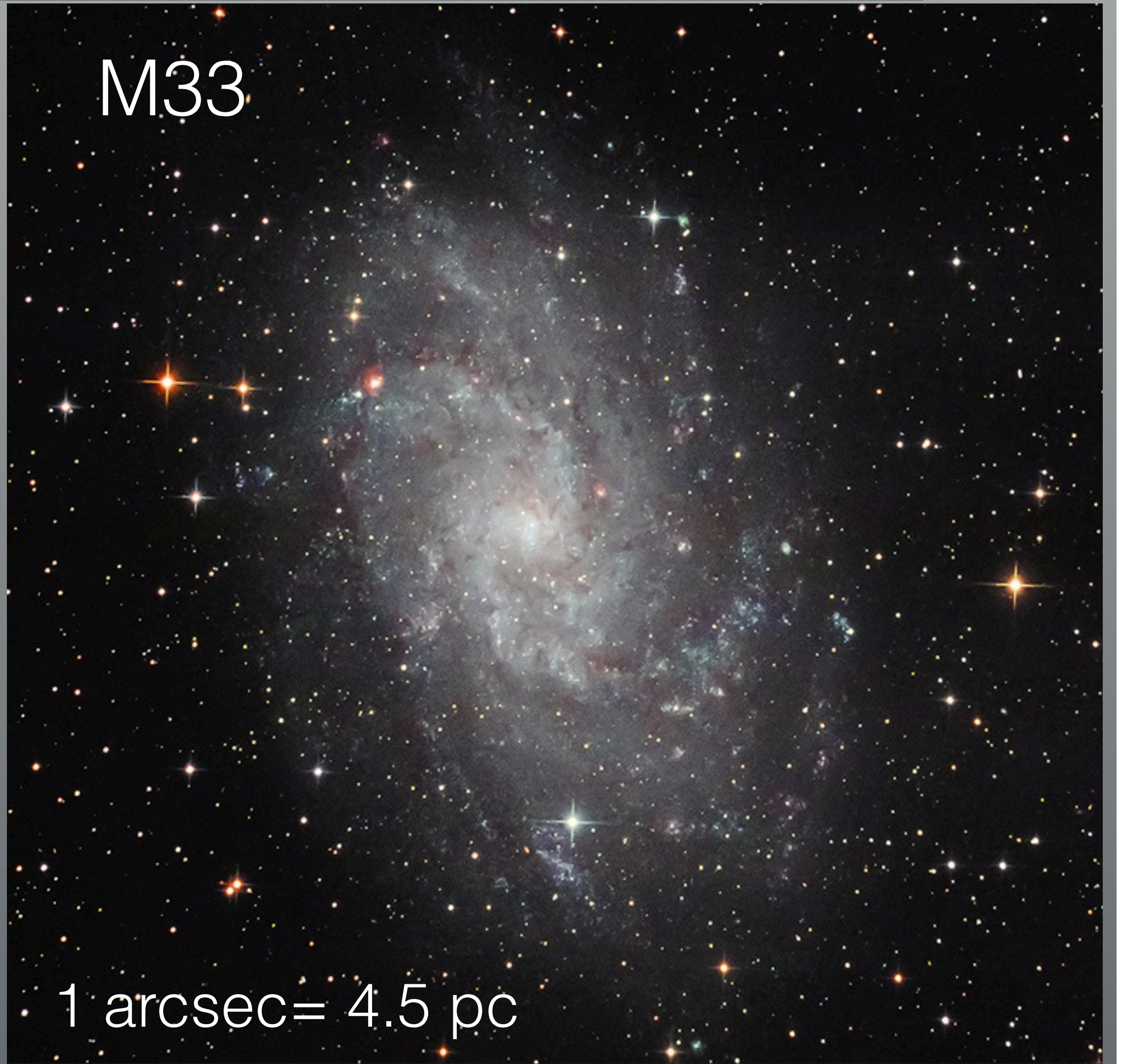
- Local group (M33, M31) can be done with Schmidt telescope
- 1 CCD + 1 spectrograph
- resolution : 30 pc (fiber size = 8 arcsec)

1 spectrograph
FoV = 3.0x3.0 arcmin
600 fibers of 100 um



Examples of galaxies and numbers of pointings

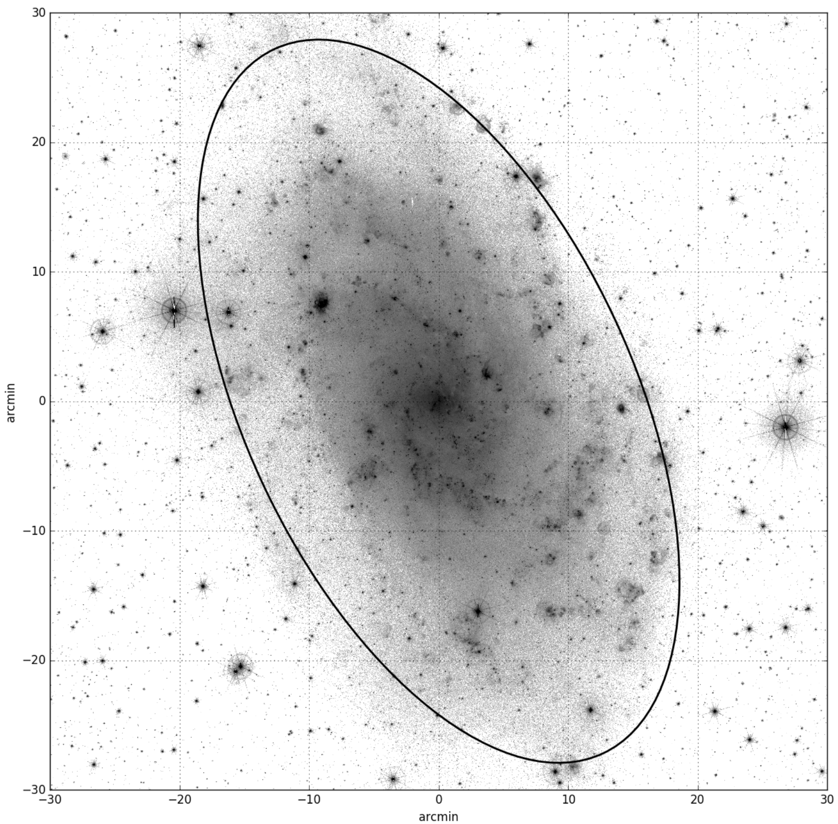




M33 and M31 can be done with small telescopes, a large FoV, and with fiber of size 5 arcsec (20 pc)
(more than 400 pointings with 3.0x3.0 arcmin FoV)

O.A. Javalambre T80   Hα

0.55 “/pixel



8 “/pixel

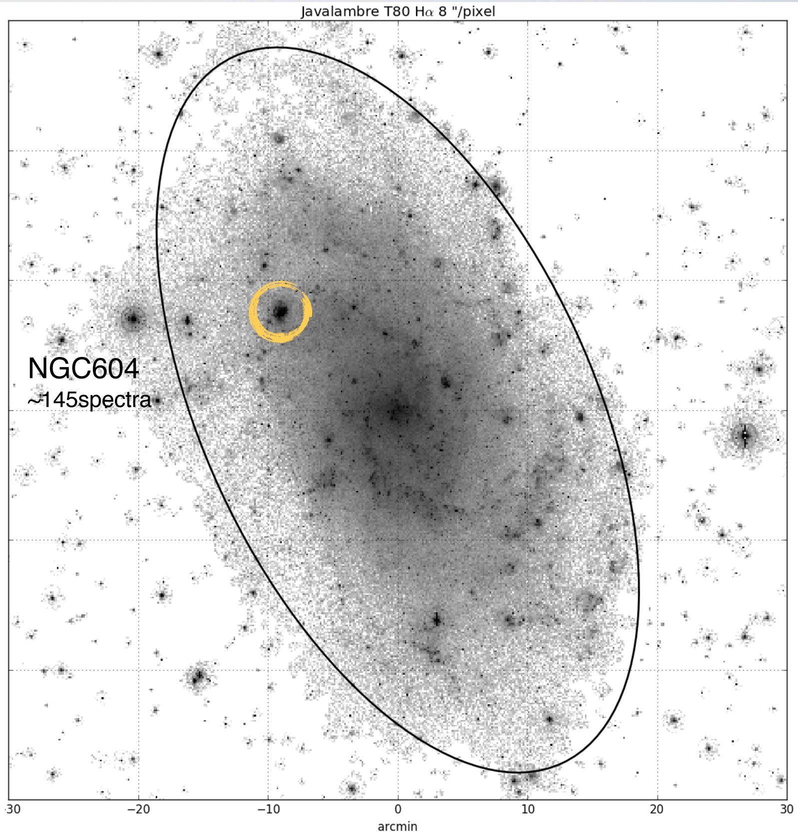
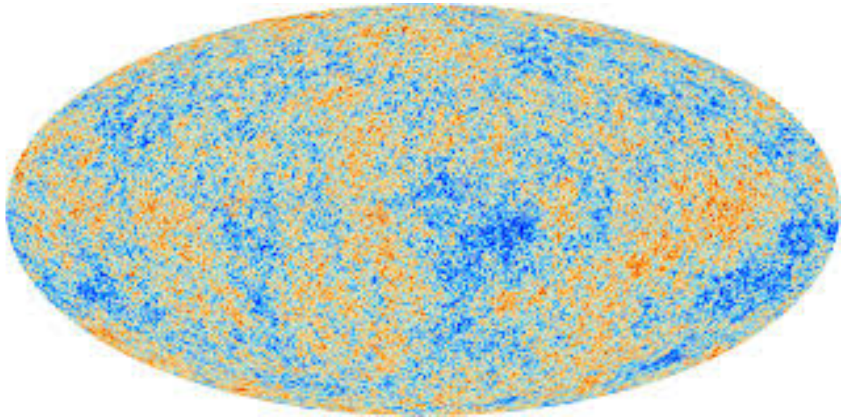


image provided by Izaskun San Román et al. (CEFCA)

A few maps

LoRCA

- At redshift 1,100 with the cosmic microwave background (COBE, WMAP, PLANCK)
- And at redshift 0.1 in the local universe, we have a photometric map: 2MASS, WISE
- We are not done with the local Universe :
  - LoRCA +TAIPAN will add a factor of 10 in redshift precision and a factor of 3 in volume.
  - A high accuracy full sky map of the local Universe is on its way



z=1100, t=3.6e5 yr   Planck collaboration 2015

z=0.1, t=1.2e10 yr   2MASS, Bilicki et al. 2015

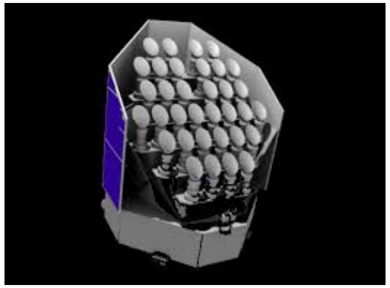
FOMBS: Follow-up of One Million Bright Stars

- Connection between the V<12 stars (with fundamental parameters) and the (tens of millions) V>14 observations from SDSS, LAMOST, HETDEX, WEAVE, 4MOST, DESI, ...
- 1 million stars over 21,000 square degrees in the Northern Hemisphere: 2600 visits of 30-min (220 clear nights or the bright time during 3 years)
- Northern hemisphere counterpart to Funnel-web

PLATO-Spec

- The PLATO – Planetary Transits and Oscillations of stars – mission was selected by ESA's Science Program Committee for implementation as part of its Cosmic Vision 2015–25 Program.
- The mission will address two key themes of Cosmic Vision:
  - what are the conditions for planet formation and the emergence of life ?
  - how does the Solar System work?
- PLATO will monitor relatively nearby stars, searching for tiny, regular dips in brightness as their planets transit in front of them, temporarily blocking out a small fraction of the starlight.
- Coverage : half the sky
- N : about 1 million stars

- When coupled with ground-based radial velocity observations:
  - PLATO's measurements will allow a planet's mass and radius to be calculated, and therefore its density, providing an indication of its composition.
  - Instrumentation: CASE fiber robotic positioner at 80-cm Schmidt telescope, and feed to a dual arm R=25,000 optical spectrograph. See figure at the end of this document.



Spectrograph Baseline

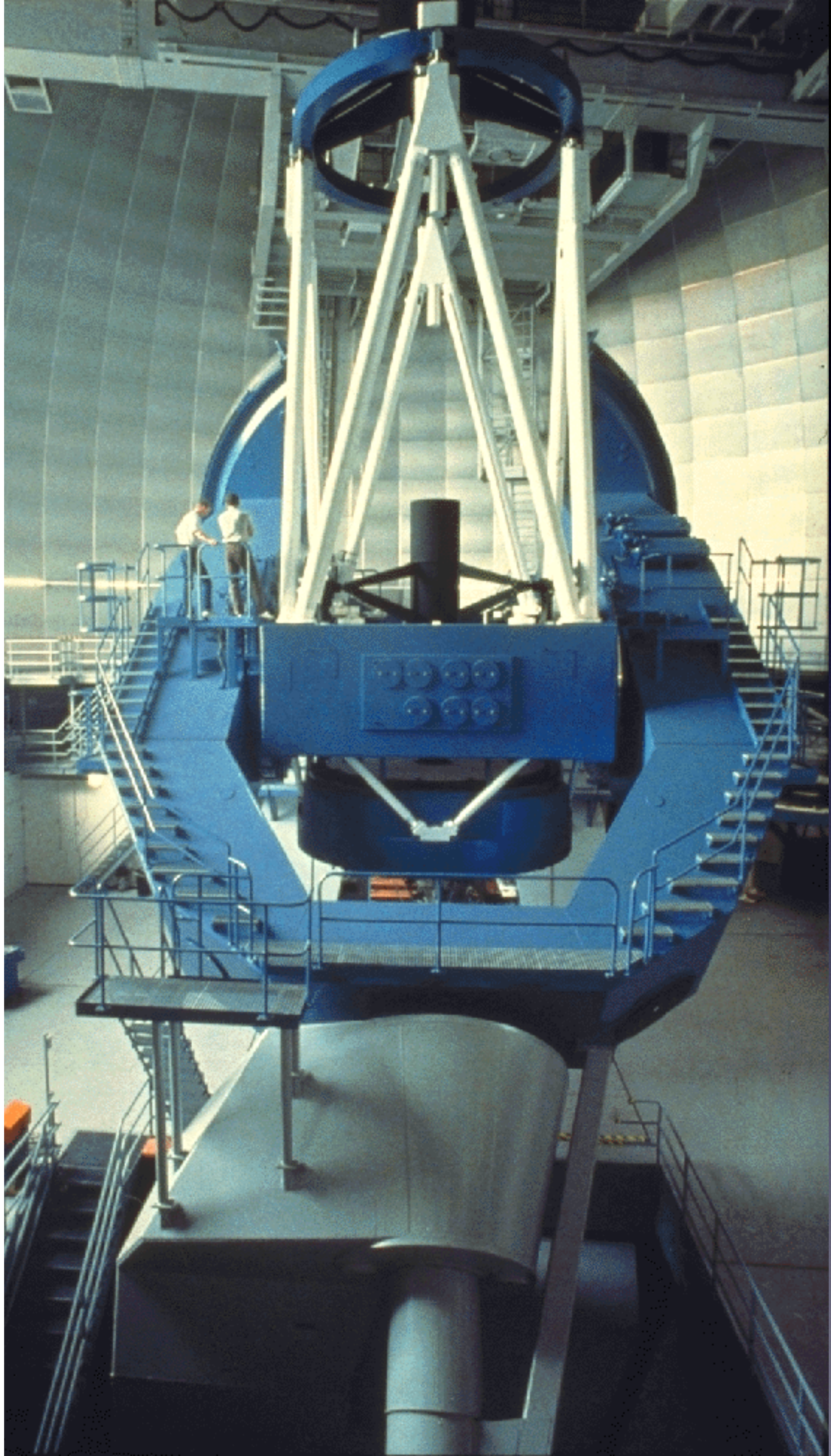
spectrograph configuration	
fiber core	120µ
single fiber FoV	10"
pitch-to-width fiber packing at slit	0.5
Number of fibers	650
15µ detector pixels per fiber	3.8
spectral resolution	2000
dispersion	1 Å/pixel
wavelength range	3600-7000 Å

10 cloned spectrographs, i.e.,

- ☑ 9 @ 3.5m telescope
- ☑ 1 @ 0.8m Schmidt

Two design solutions:

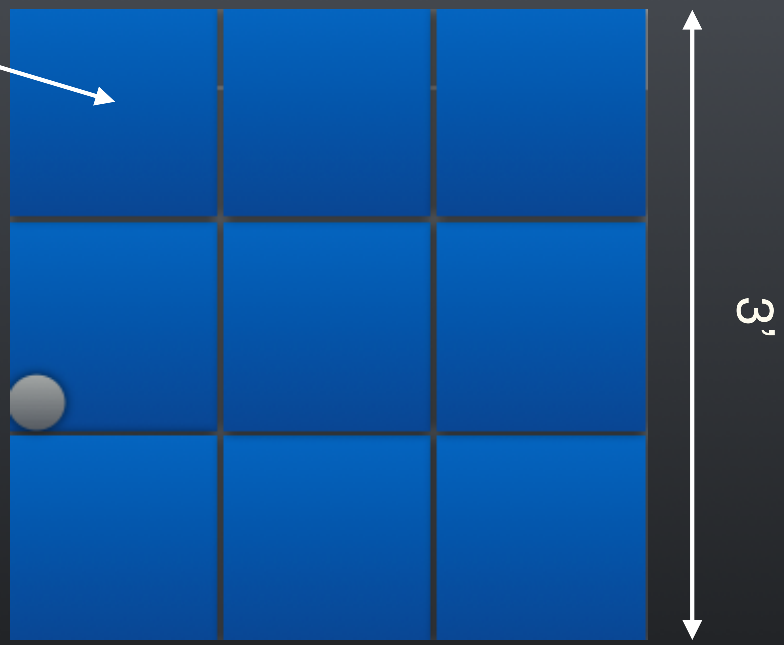
1. DESI-like design by LAM & Winlight
2. Taipan/Hector-like design by AAO

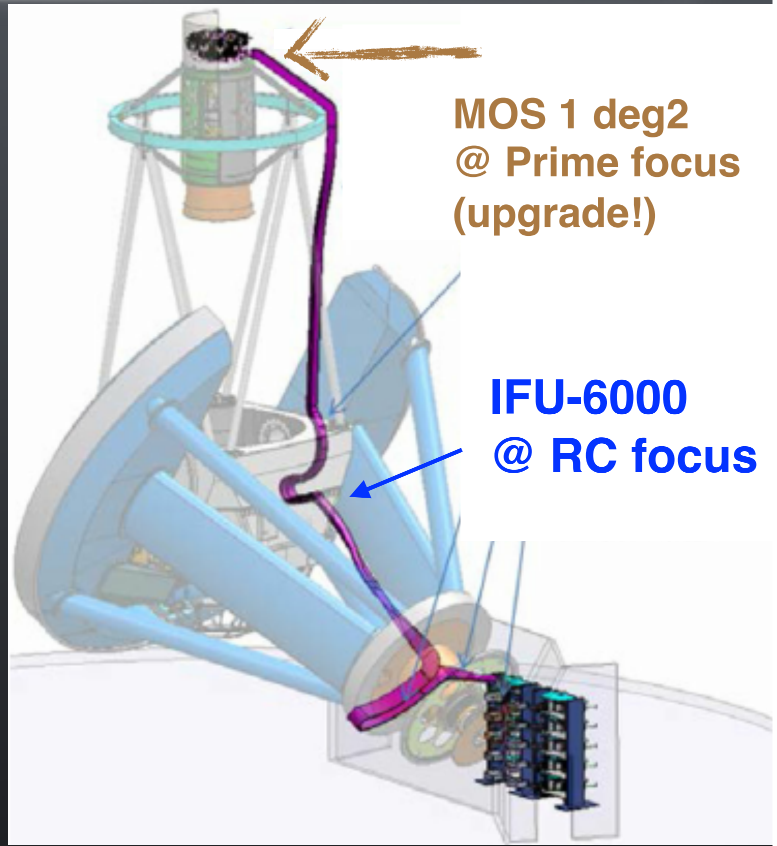


Calar Alto 3.5m telescope

corrector		prime-system		RC-system
		2 lens	3 lens	
aperture	mm	3 500		
focal length	mm	12 195	13 761	35 000
central obscuration	mm ø	820		1367
eff. coll. area	m²	9.093		8.153
f/ratio		1/3.48	1/3.93	1/10.0
FOV	mm	100	243	300
	arcmin	28.19	60.71	29.47
scale	"/mm	16.9	15.0	5.89
radius of field curvature	mm	infinite		-3786
hourangle range	h	-7 to +7		

IFU-6000 @ 3.5m



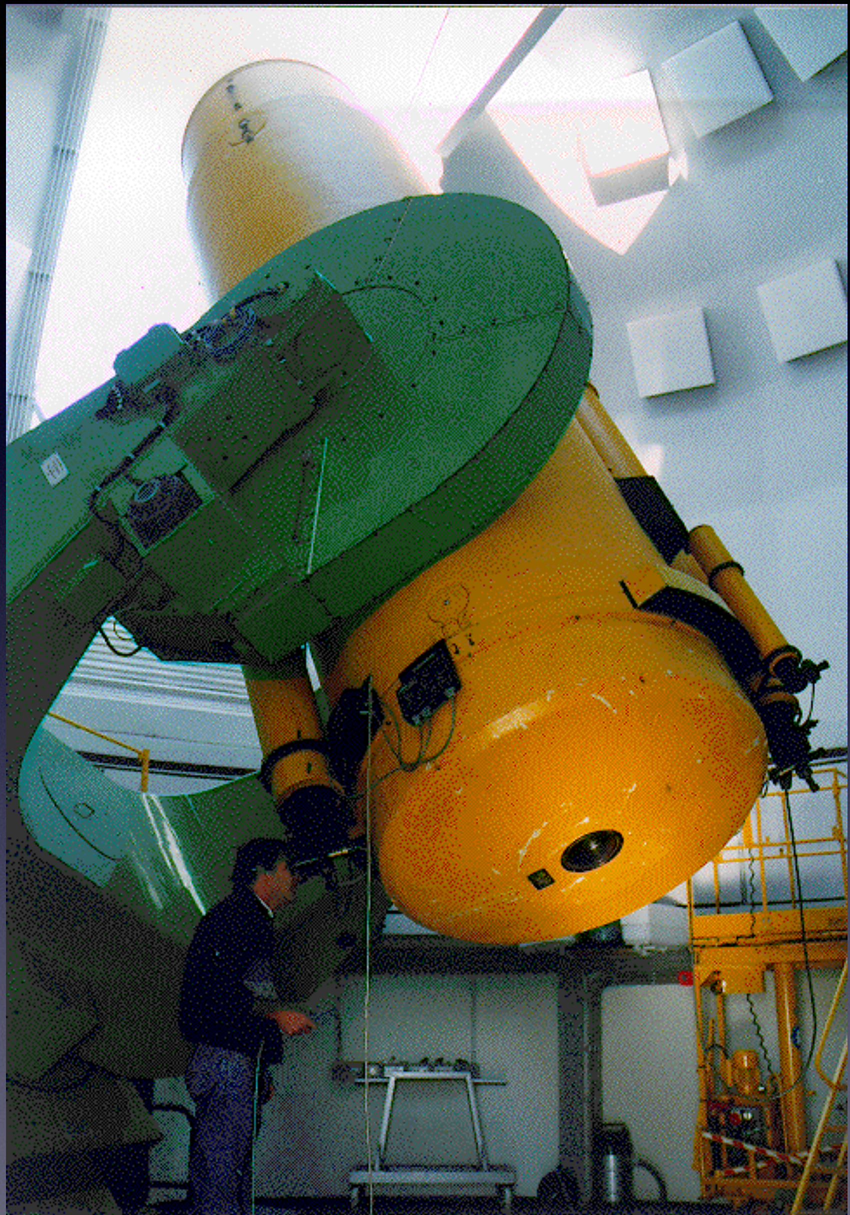


9 cloned spectrographs each fed with 650 fibres packed in a microlens array

F.o.V = 3 x 3 arcmin (2.5” per fiber)

40 m cable from telescope to spectrograph room

Calar Alto Schmidt 80cm

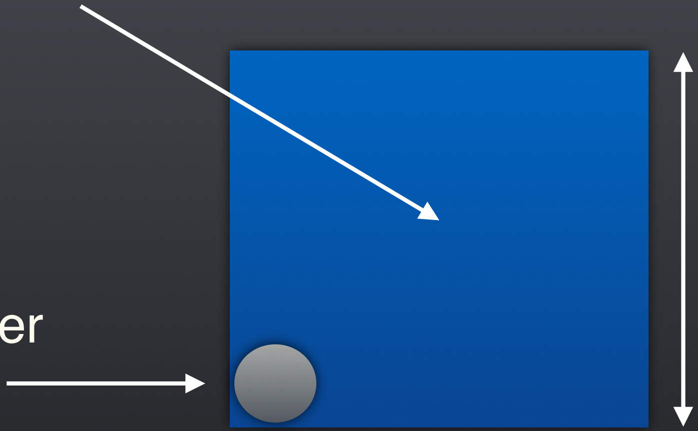


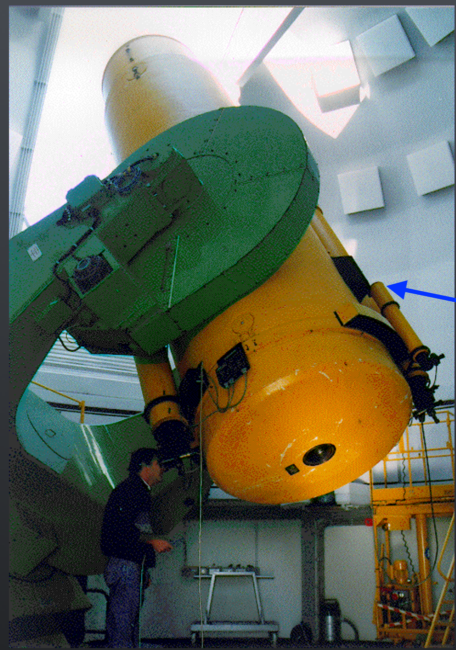
aperture	mm	800
focal length	mm	2400
f/ratio		1/3
FOV	°	8
	mm	335
plate format	inch	8 x 10
scale	"/mm	86.2

IFU-600 @ Schmidt

Fiber Array
of 650 fibres

8.5” per fiber

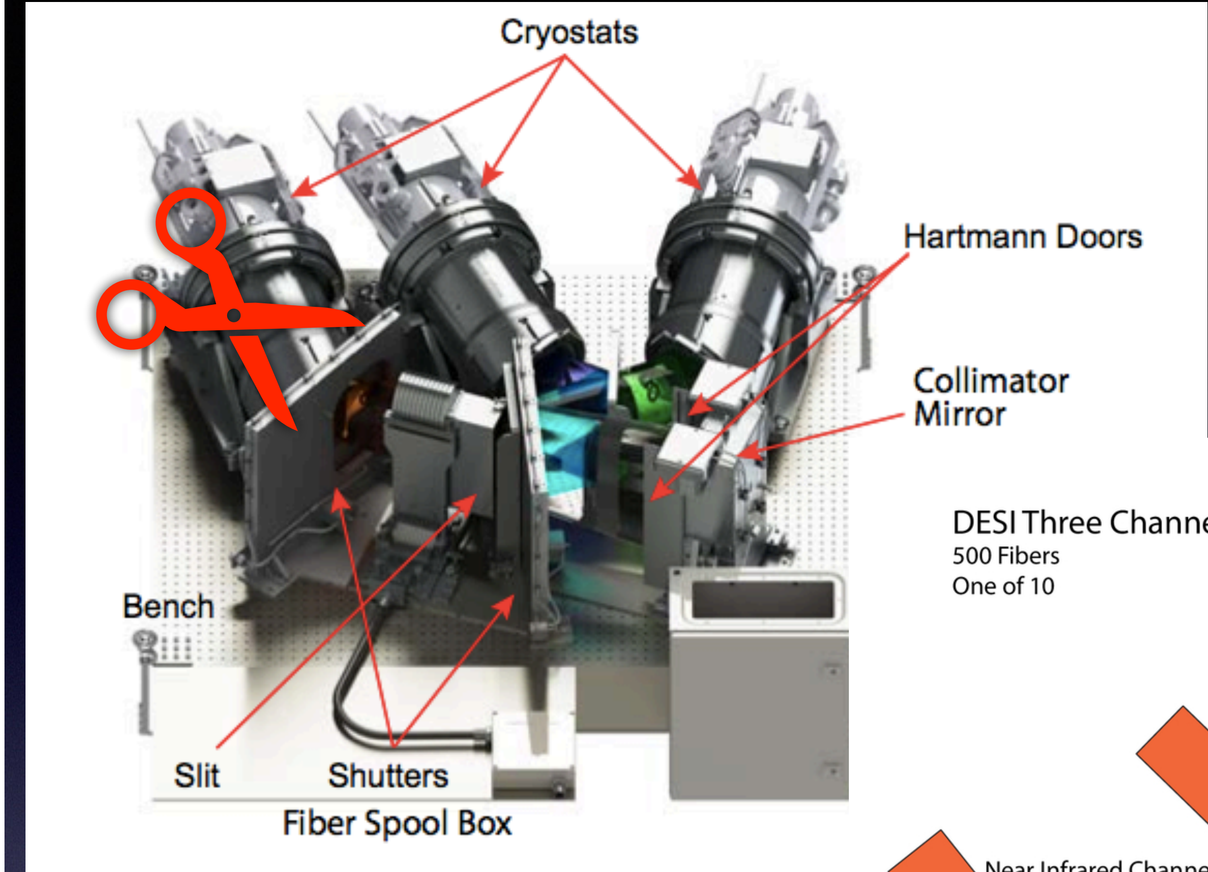




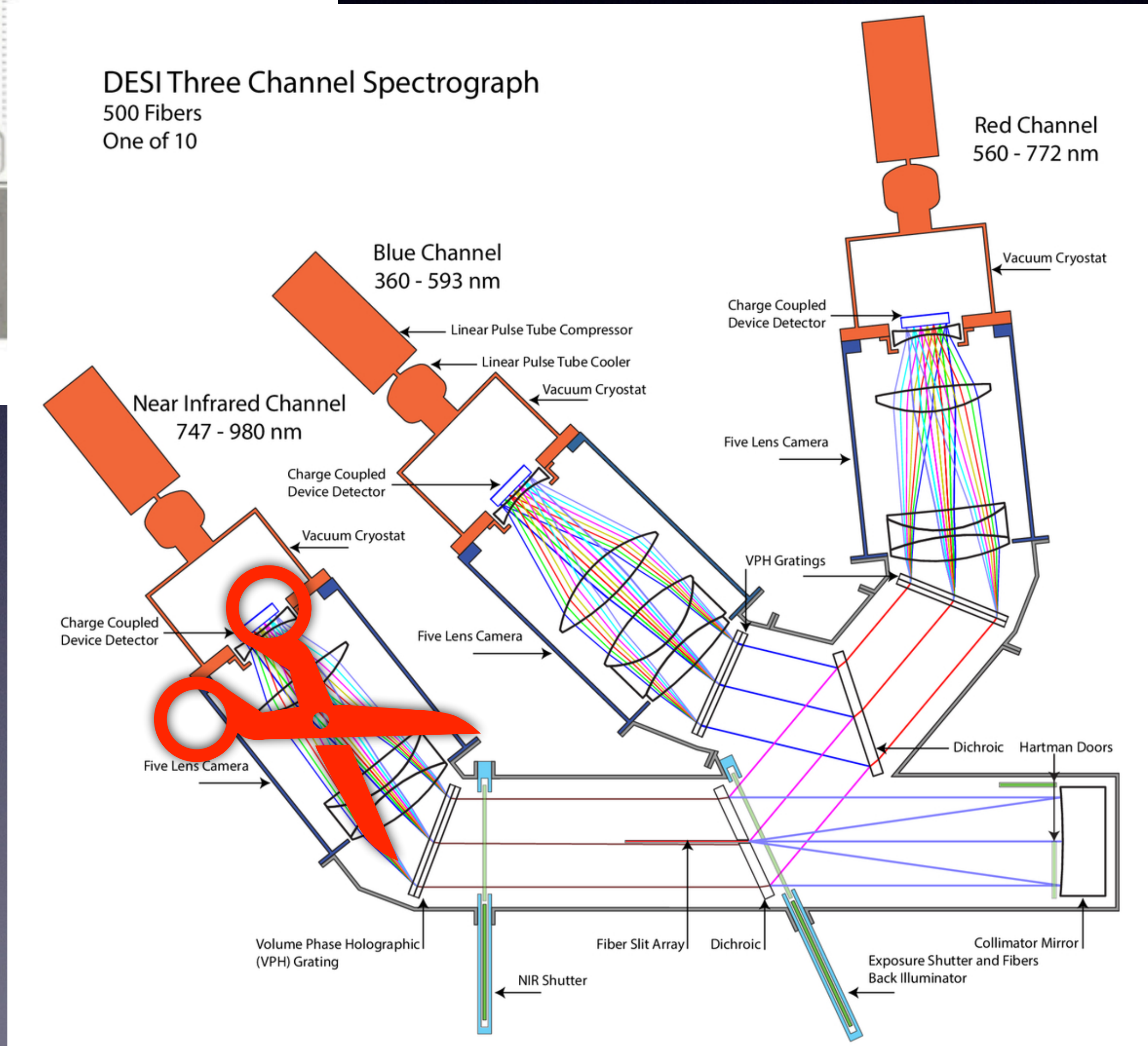
IFU-600
+
MOS 50 deg2!!

8 deg

1 spectrographs fed with 650 fibres packed
IFU F.o.V = 3.5 x 3.5 arcmin (8.5” per fiber)
MOS F.o.V = 50 deg2 (200 fibers)
15 m cable from telescope to spectrograph room



"2-arm" DESI spectrograph Winlight in Marseille is NOW building 15 of them!



Very minor re-design to remove the reddest arm, have 2 parallel slits and perhaps increase the red coverage up to 800nm

Remarks

Feasibility Study Phase: 15 October 2018 to 15 April 2019

Kick-off Instrumentation Meeting in Marseille @ LAM: 19-21 September 2018
(September 18-19 Workshop on Peculiar Velocity Surveys)

First IFU-600 @ Schmidt can be ready in less than 2-years!

Need HELP & SUPPORT from YOU!