Determining AGB mass loss histories form Planetary Nebulae: towards hexabundle MOS of Magellanic Cloud PNe

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The PNHALO Collaboration:

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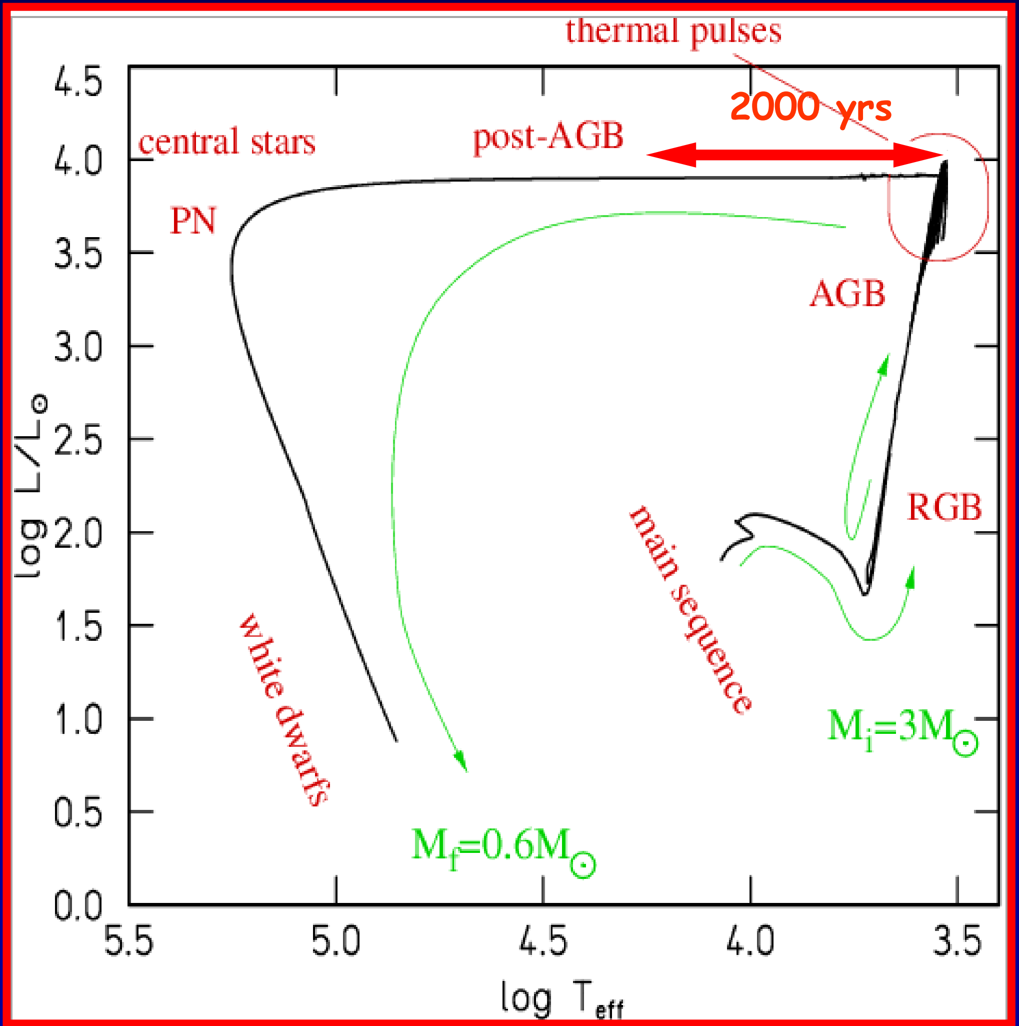
Mike Barlow	(UCL)	Herschel GTO, MESS [1)]
Robin Ciardullo	(Penn State)	PNLF, VIRUS/HET
Romano Corradi	(IAC)	atlas of haloes of PNe
David Frew	(Perth)	LMC/SMC, GC
Peter Hauschildt	(Hamburg)	stellar atmospheres, opacities
Falk Herwig	(Victoria)	nucleosynthesis
Francesca Matteucci	(Trieste)	chemical evolution of galaxies
Ana Monreal-Ibero	(ESO)	3D spectroscopy
Quentin Parker	(Macquarie)	LMC/SMC, GC
Warren Reid	(Macquarie)	LMC/SMC, GC
Richard Shaw	(NOAO)	HST imaging LMC/SMC PNe
Yannis Tsamis	(Granada)	3D spectroscopy, PNe
Jeremy Walsh	(ESO, STECF)	3D spectroscopy, PNe
Albert Zijlstra	(Manchester)	AGB stars, winds

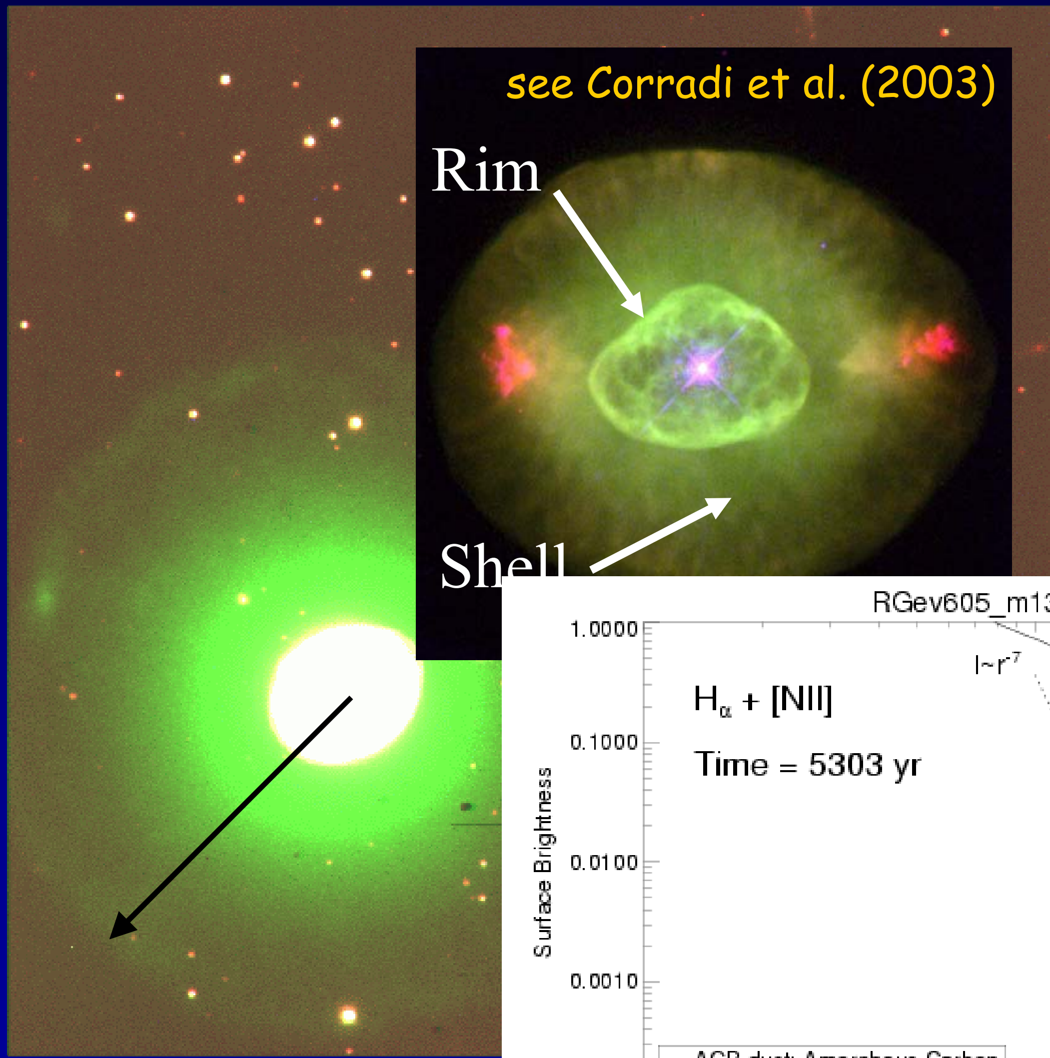
(1) AGB mass loss: major contribution to cycle of matter in galaxies

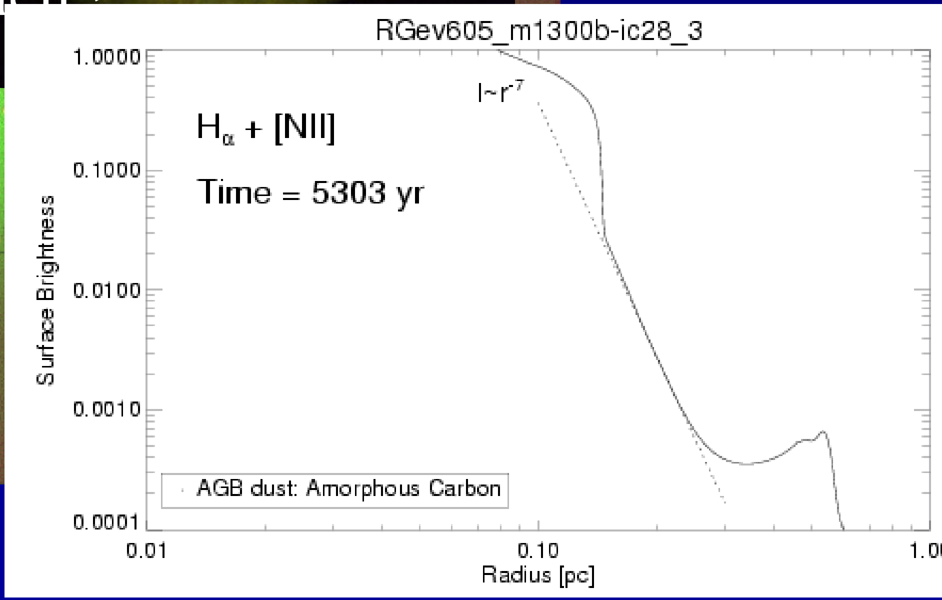


- Strong, dust-driven stellar winds
- Enriched by freshly synthesized elements dredged-up from interio
- Important contribution to the recycling of matter in galaxies
- Short lifetime of high mass loss phases prevents direct detection
- Theory of mass loss on the AGB and beyond is highly uncertain

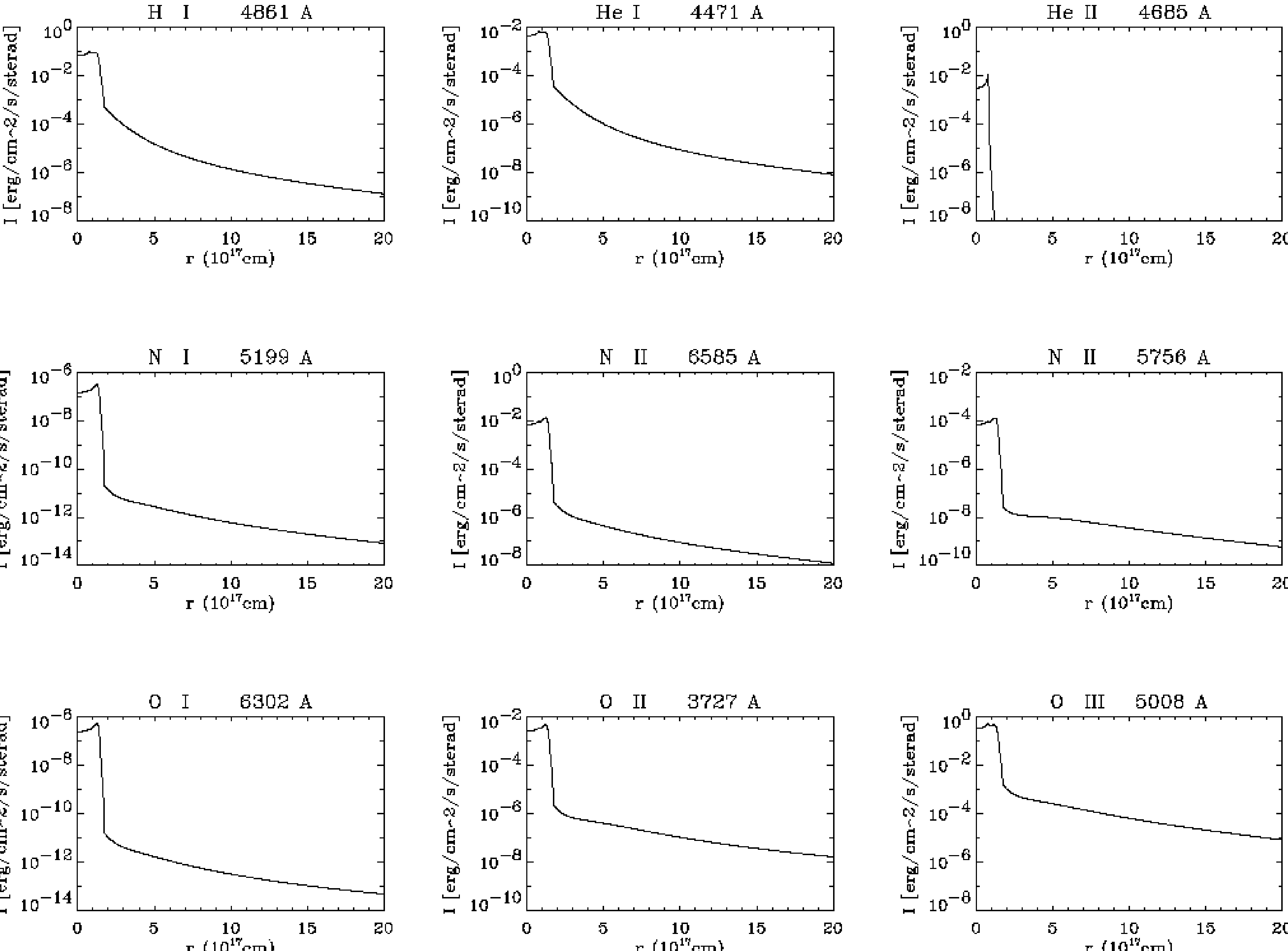
Goal: empirical mass loss determination using haloes of PNe

NGC6826 (PMAS A&G Camera, CAHA 3.5m)

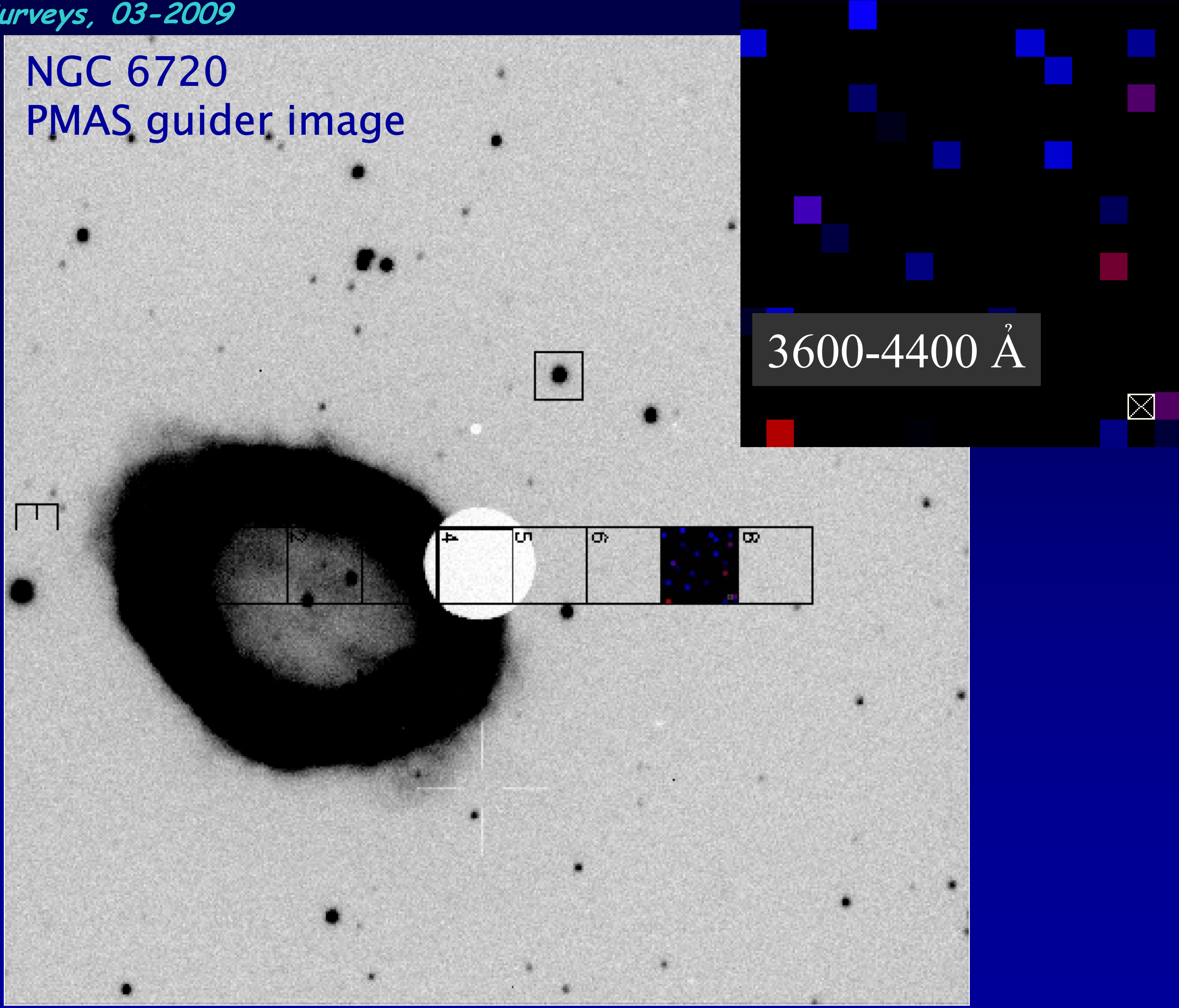


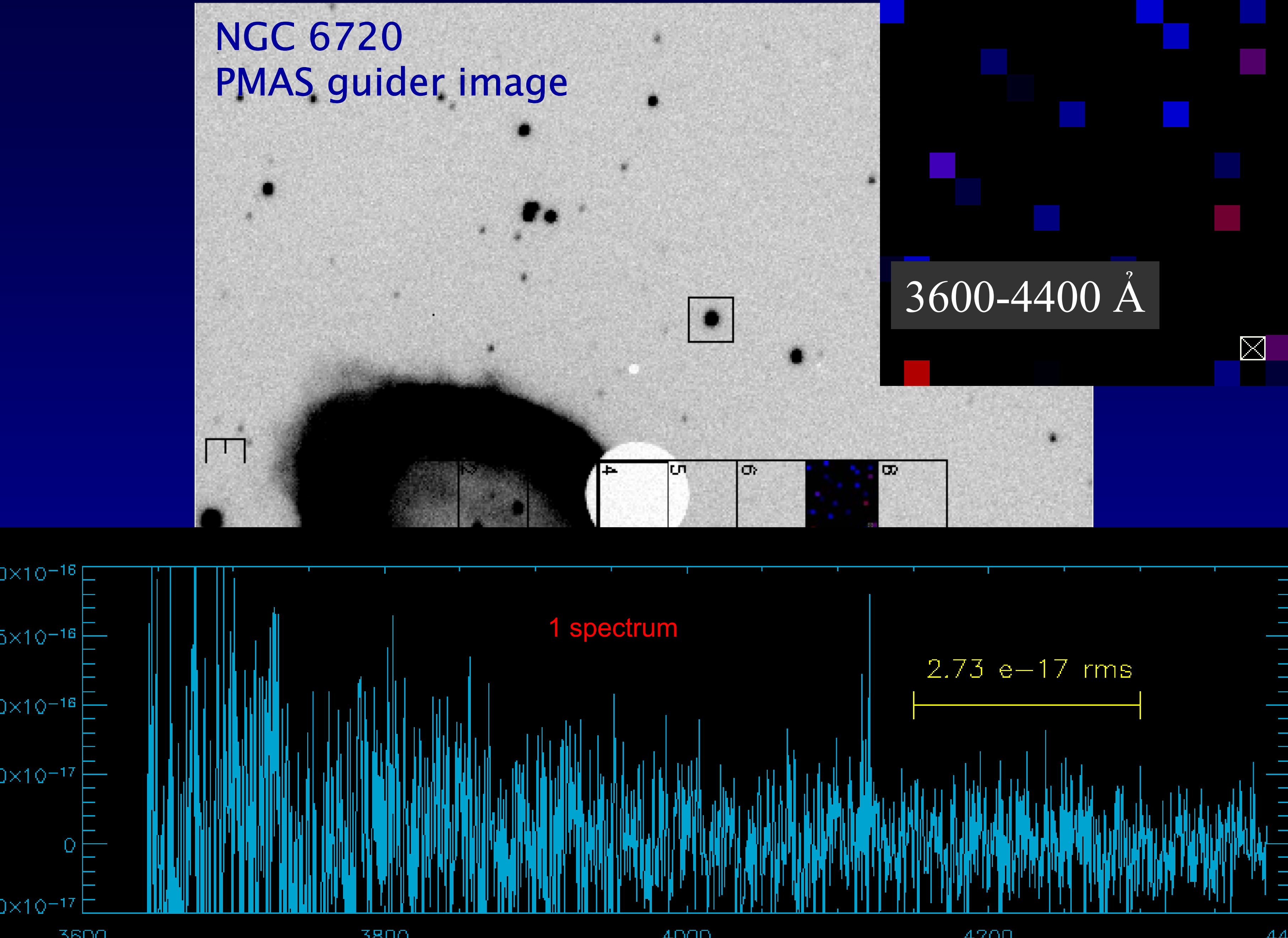


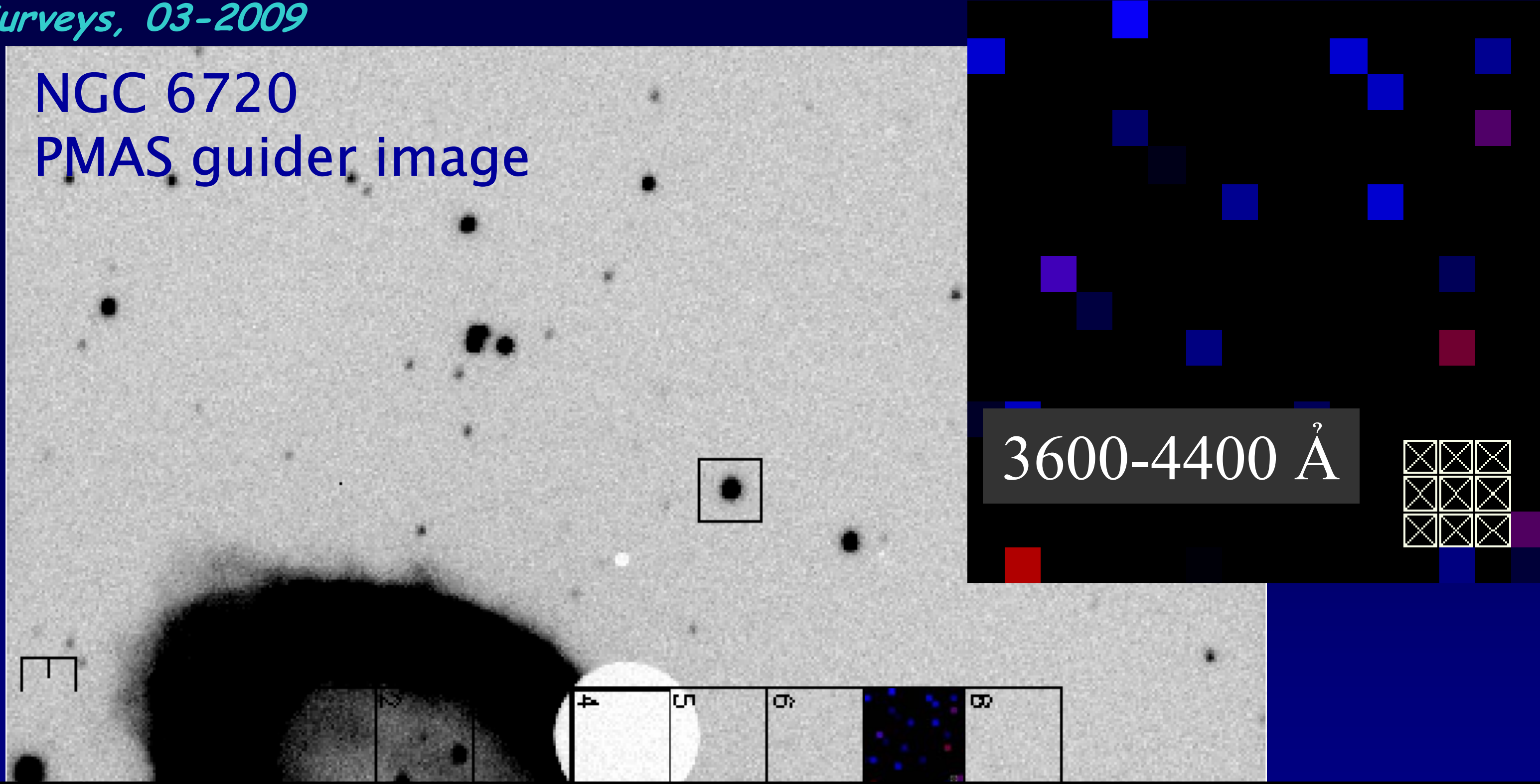
Schönberner & Steffen 2002

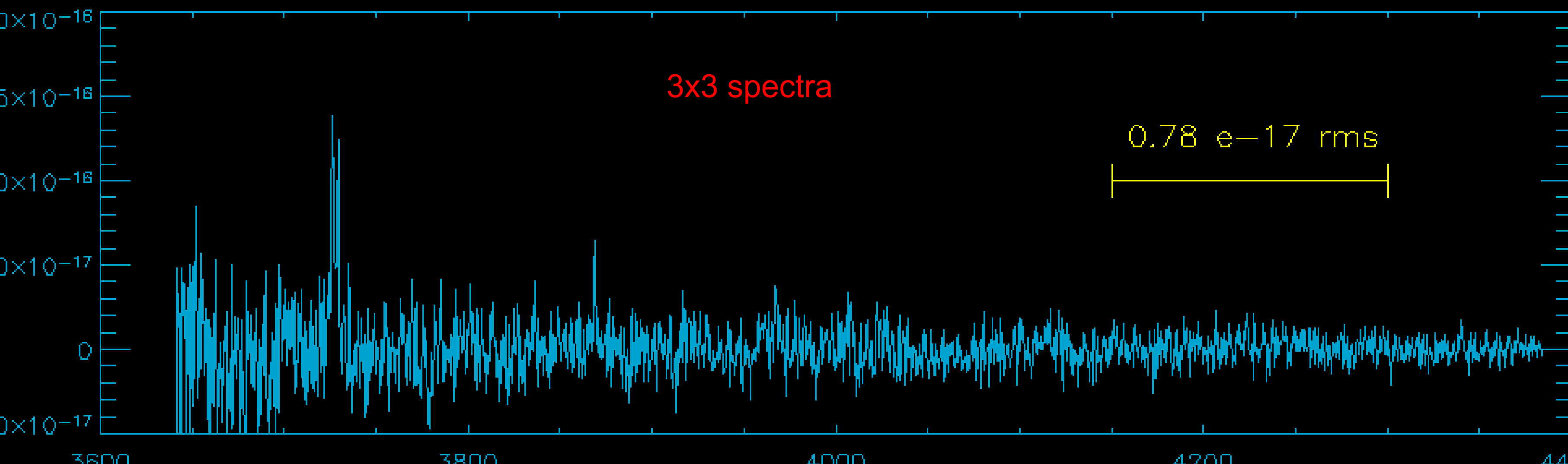


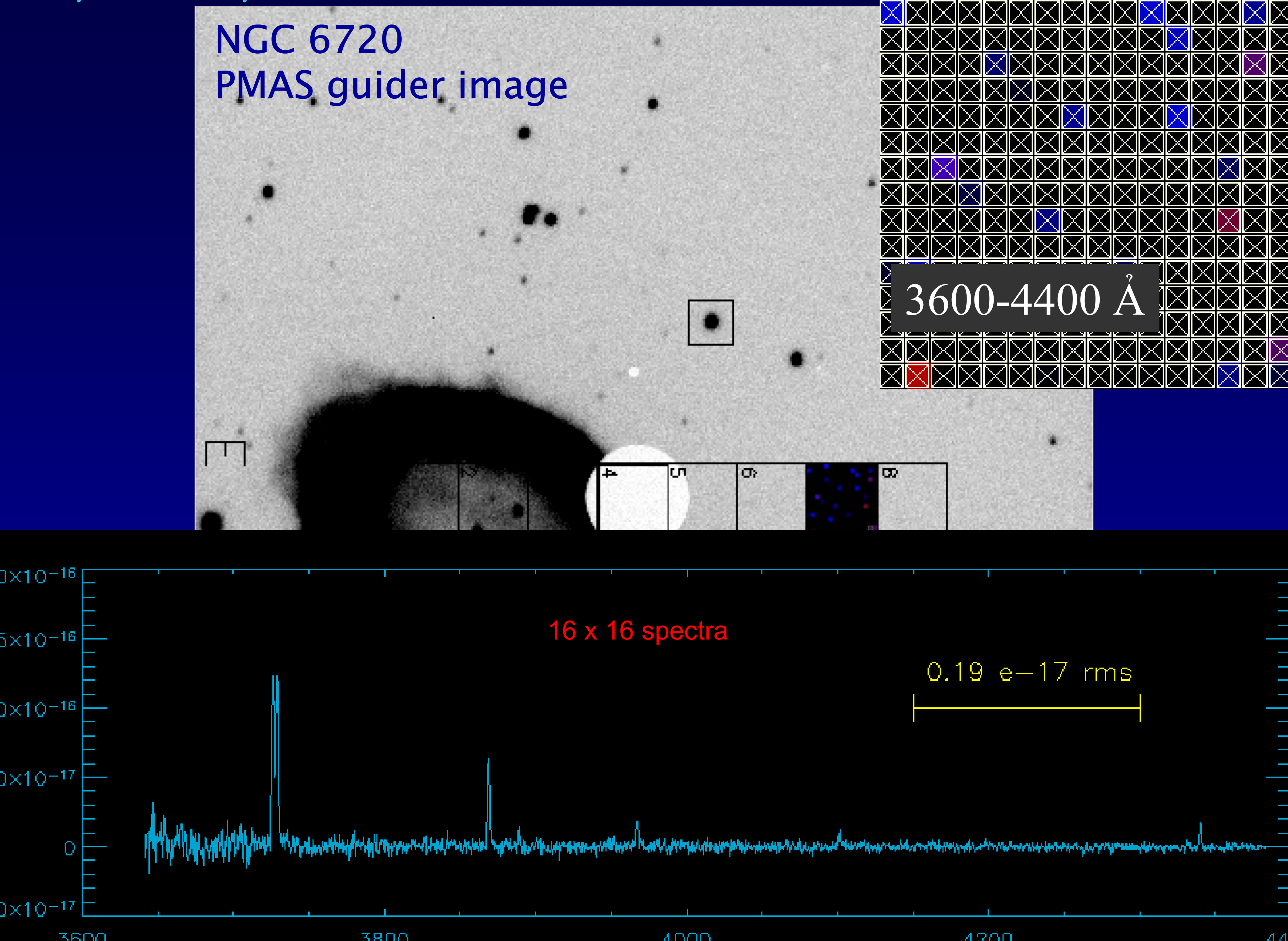
H I 4861 A
He I 4471 A
He II 4685 A
N I 5199 A
N II 6585 A
N II 5756 A
O I 6302 A
O II 3727 A
O III 5008 A
I [erg/cm^2/s/sterad]
r (10^{17}cm)


NGC 6720
PMAS guider image
3600-4400 Å


NGC 6720
PMAS guider image
3600-4400 Å
1 spectrum
2.73 e−17 rms
0


NGC 6720
PMAS guider image
3600-4400 Å


3x3 spectra
0.78 e−17 rms
0
3800
4000
4200


NGC 6720
PMAS guider image
3600-4400 Å
16 x 16 spectra
0.19 e−17 rms
3800
4000
4200

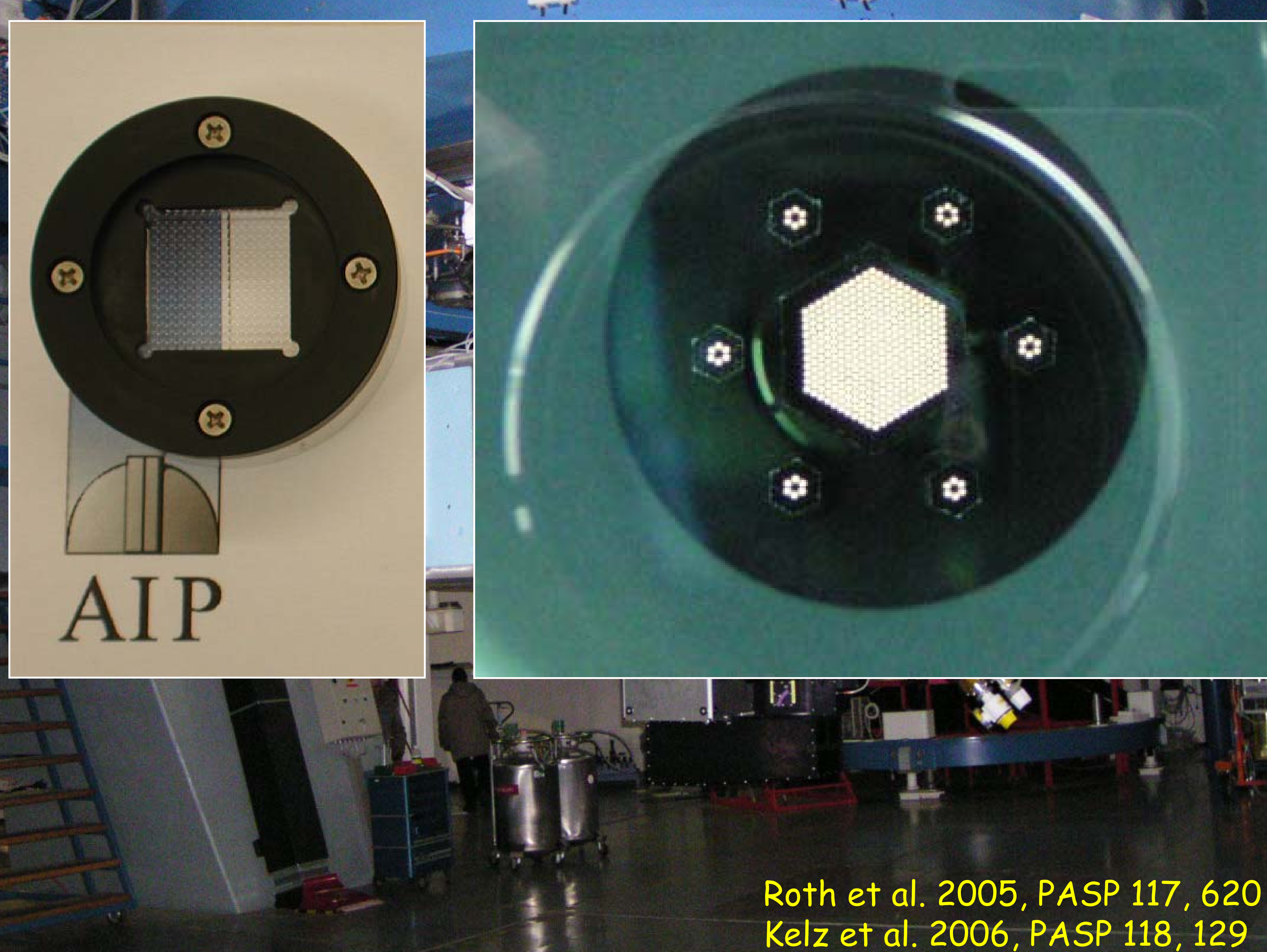
PNHALO-Project: Radiation-Hydrodynamics Simulations + Integral Field Spectroscopy

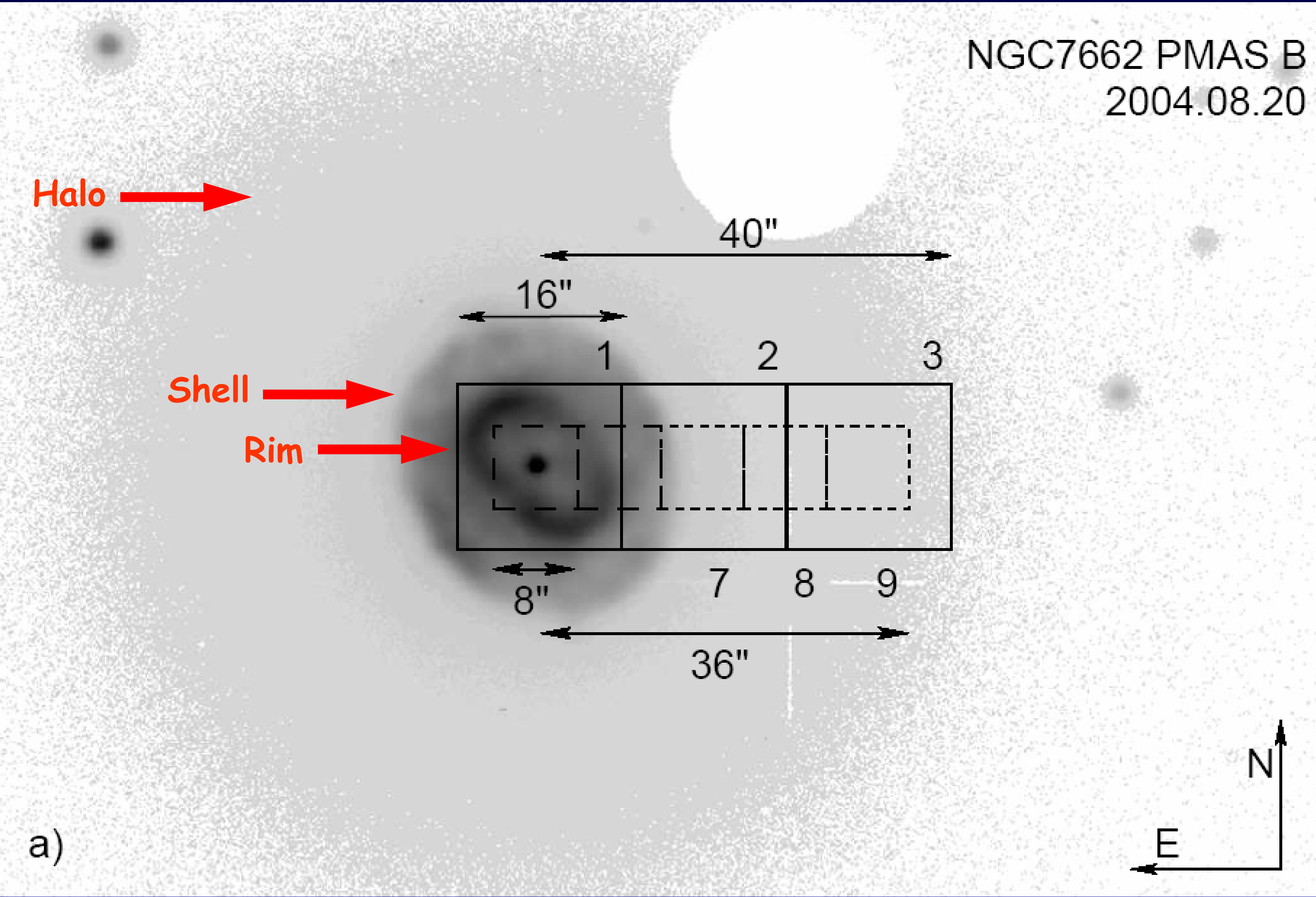
Goals:

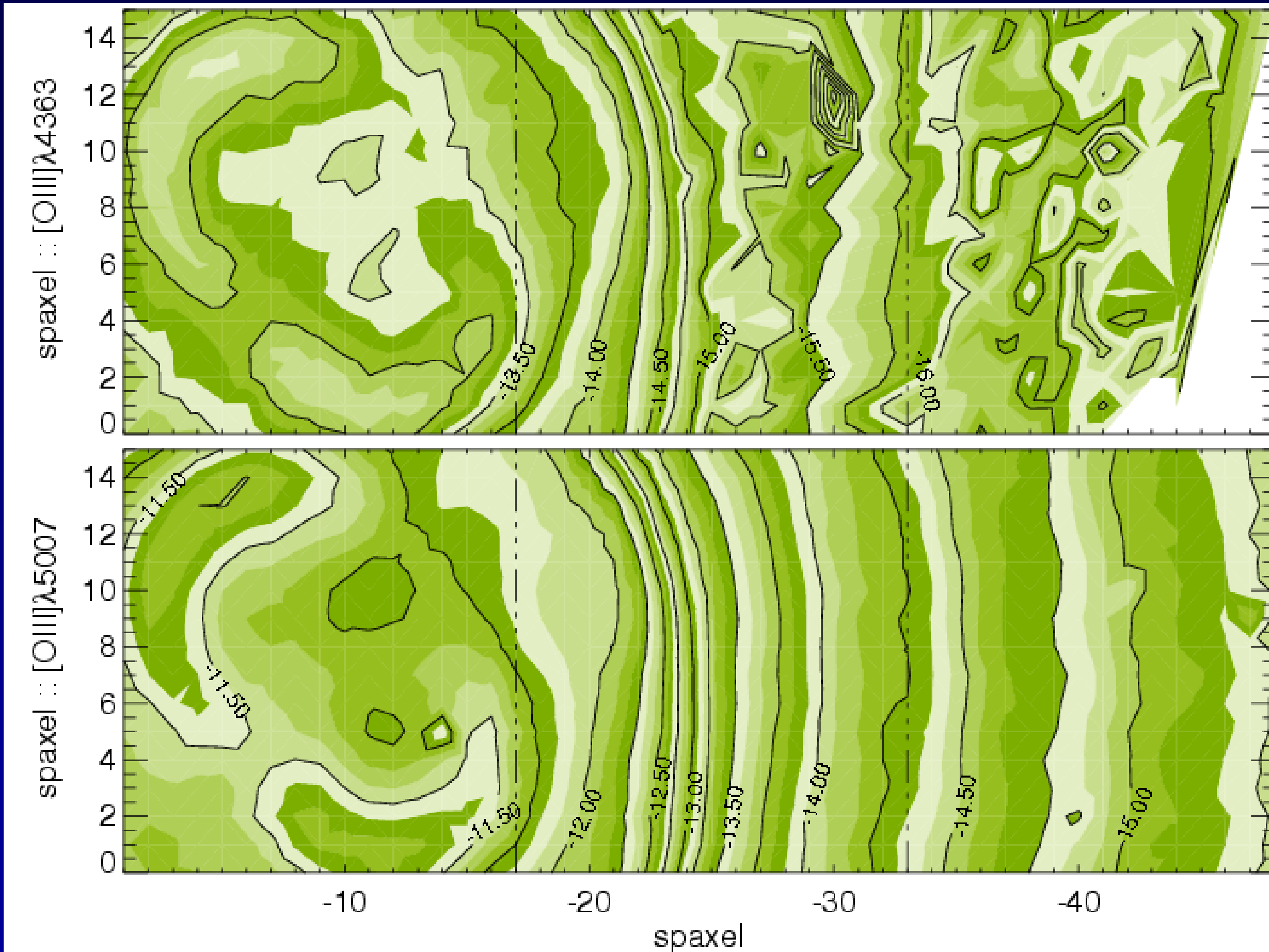
- Radial density structure → final mass loss episode
- Temperature, density → type and age of halo
- Chemical abundances → nucleosynthesis & dredge-up
- *Detection of new haloes not found by dire*
- *Physics of ring structures within haloes*

(2) PMAS Pilot Study

Sandin et al. 2008, A&A 486, 545

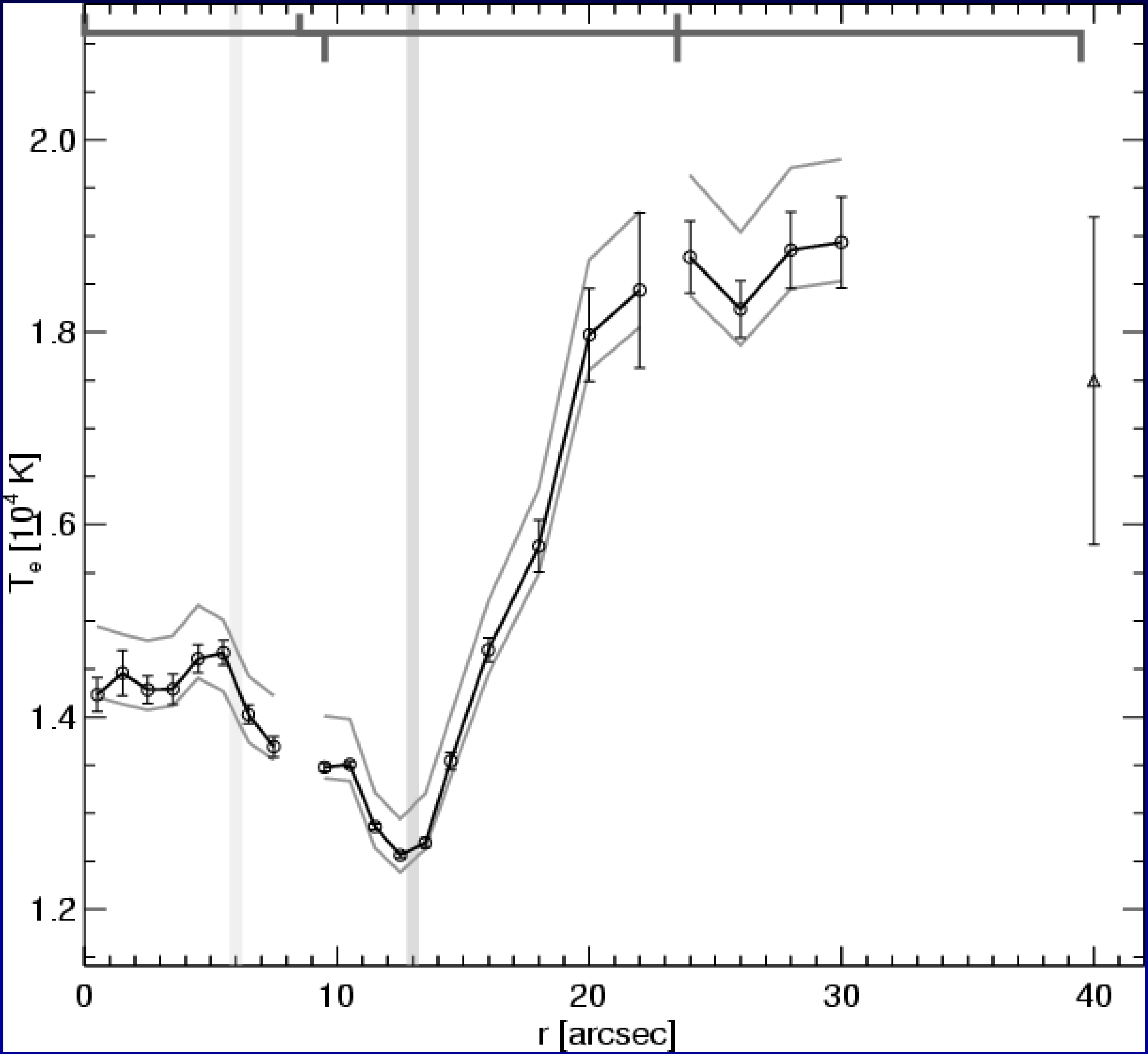

AIP
Roth et al. 2005, PASP 117, 620
Kelz et al. 2006, PASP 118, 129


NGC7662 PMAS B
2004.08.20
Halo
Shell
Rim
40"
16"
1
2
3
7
8
9
8"
36"
a)
N
E

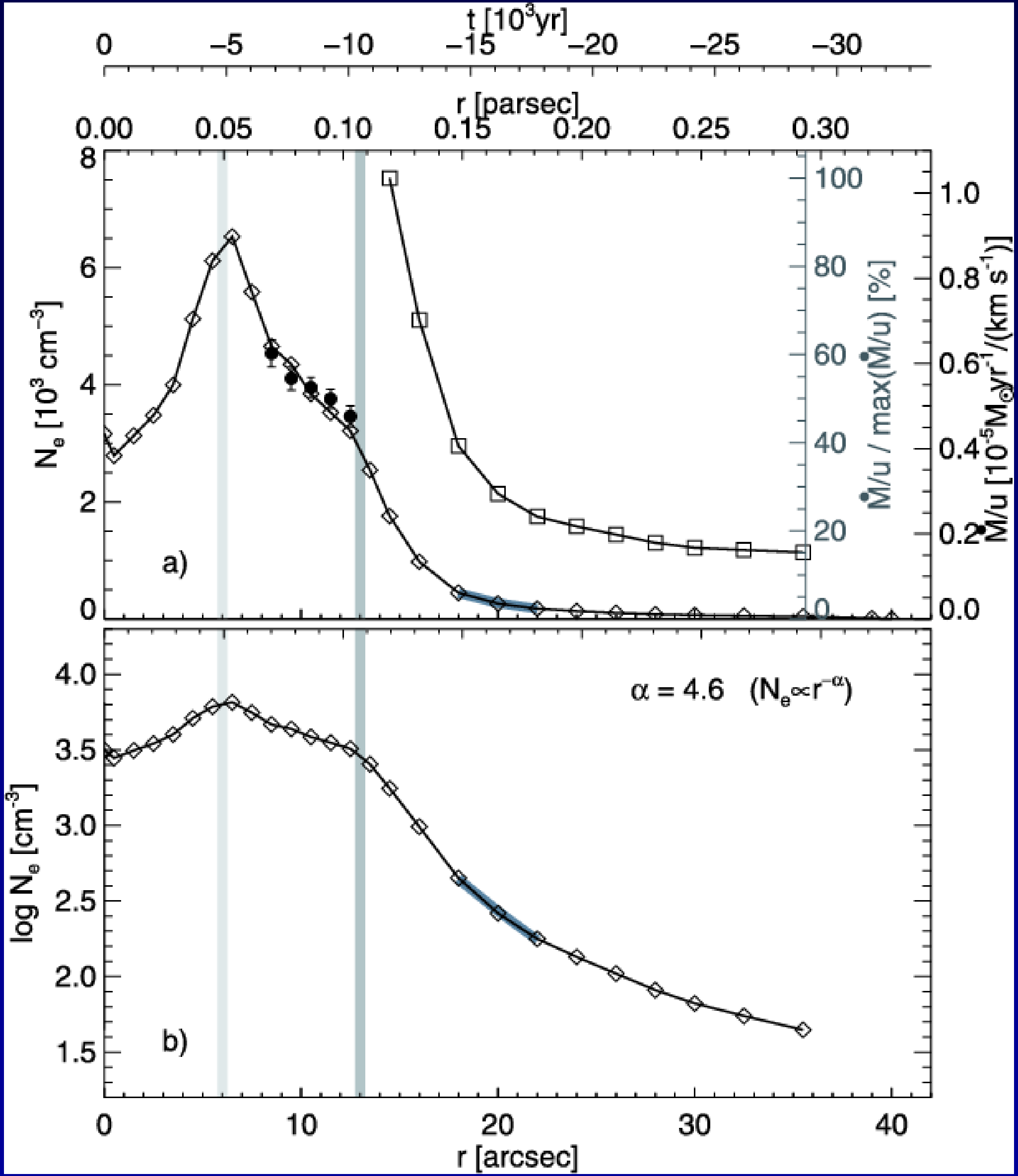


spaxel :: [OIII]λ4363
14
12
10
8
6
4
2
0
-13.50
-14.00
-14.50
-15.00
-15.50
-16.00
spaxel :: [OIII]λ5007
14
12
10
8
6
4
2
0
-11.50
-11.50
-11.50
-12.00
-12.50
-13.00
-13.50
-14.00
-14.50
-15.00
-10
-20
-30
-40
spaxel

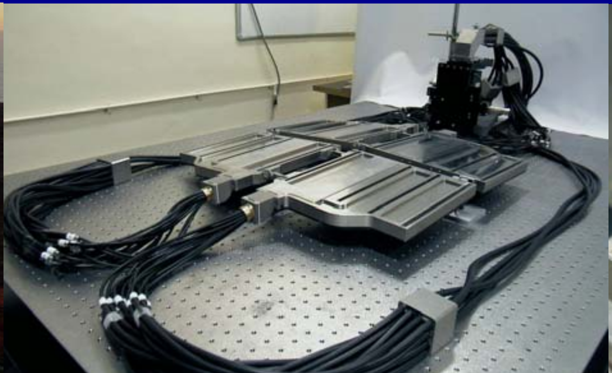
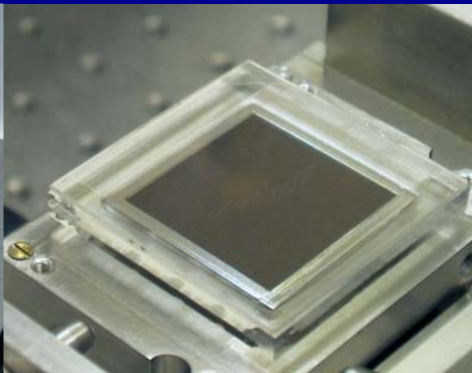
temperature profile



density profile
and mass loss history



(3) VIMOS-IFU Test

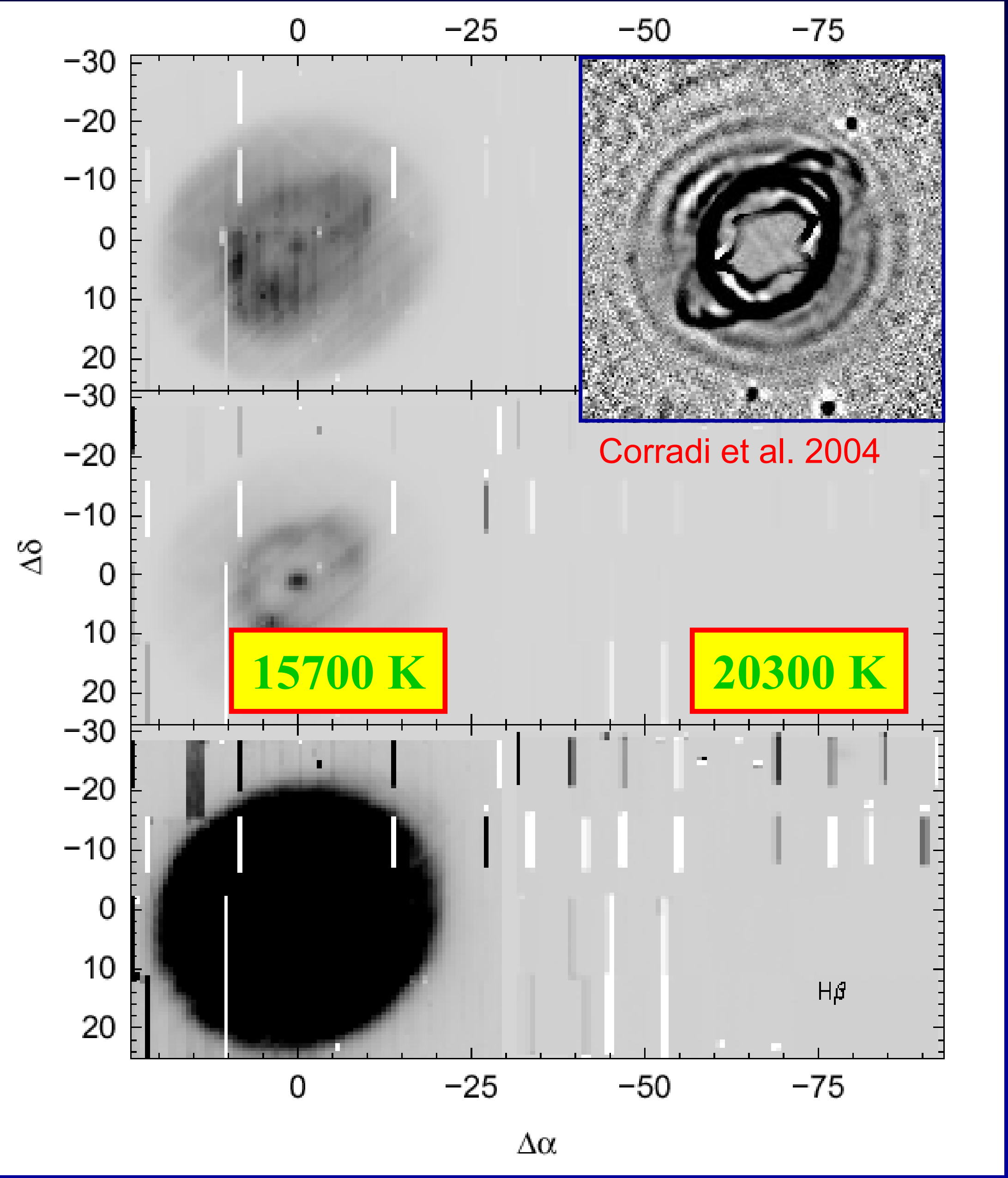
NGC 3242

T_{eff} = 68000 K
log g = 4.6
M = 0.65

VIMOS-IFU
54″ x 54″

Mosaic of 3 pointings

Monreal et al. 2005
ApJ 628, L139



VIMOS-IFU instrumental issues :

- data reduction robustness
- response variation f(x,y), f(t)
- flux calibration
- wavelength calibration
- image quality / scattered light

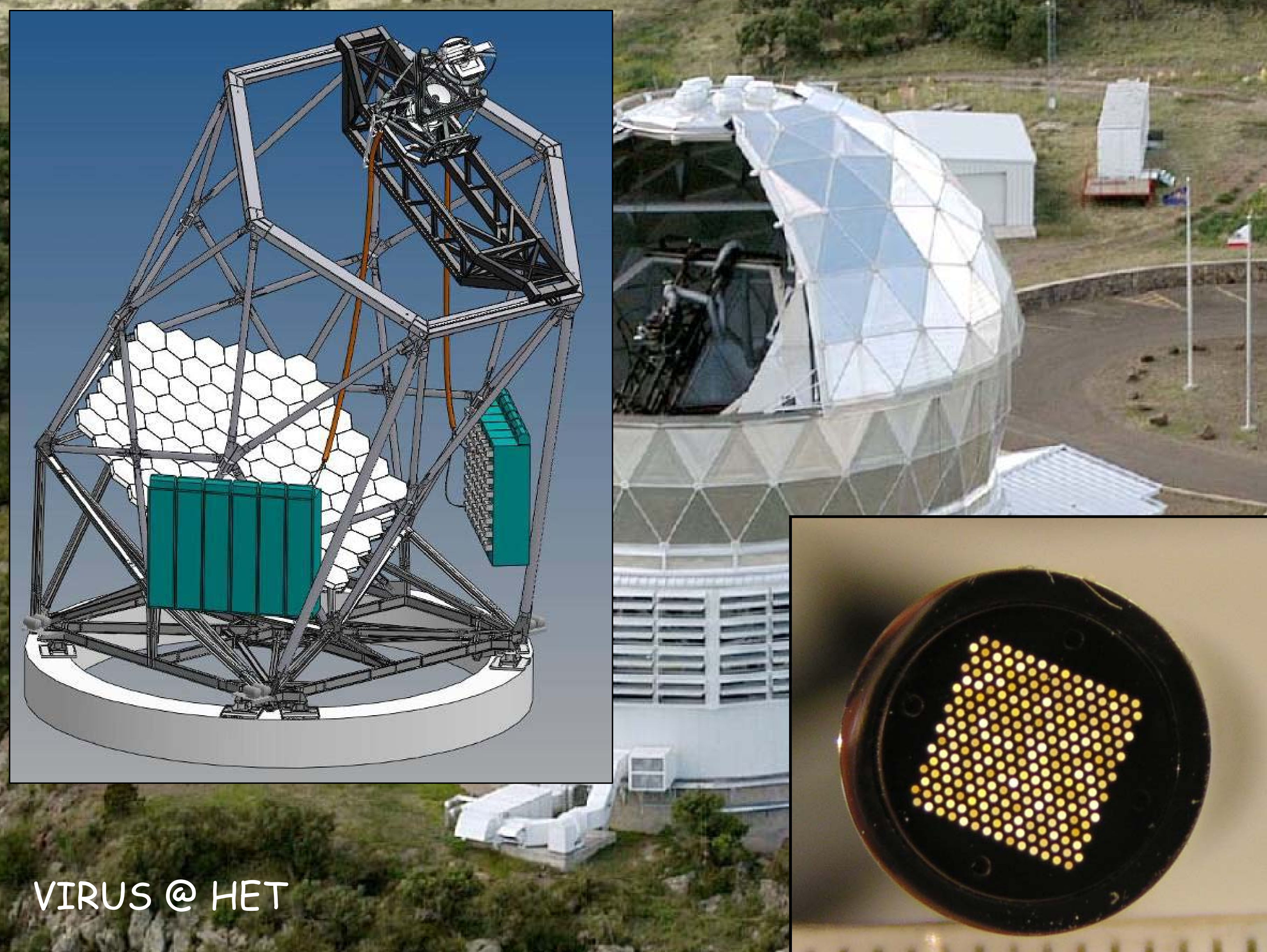
see: Roth et al. 2008, Proc. ESO Instrument Calibration Workshop

(4) VIMOS-IFU Large Program - Step 1: feasibility demonstration

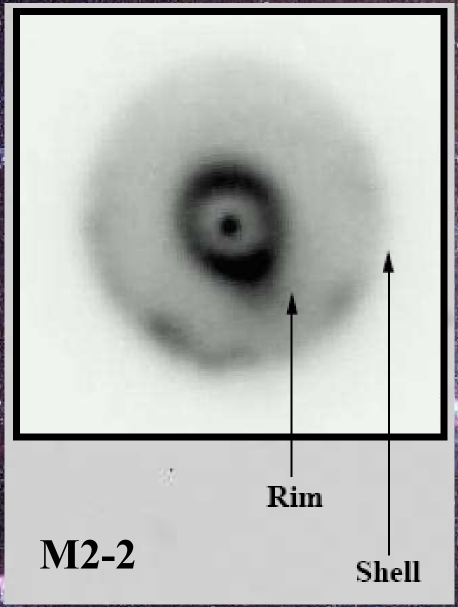
C. Sandin, A. Monreal-Ibero, M.M. Roth, M.Steffen, D. Schönberner, J. Walsh, R. Corradi

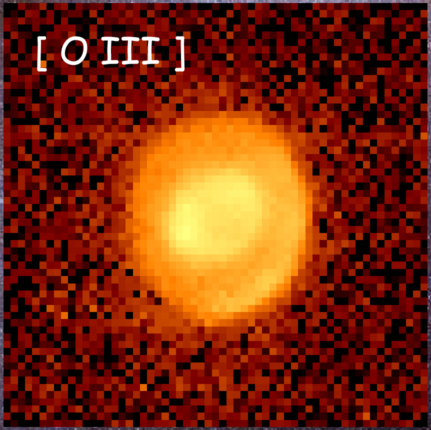
"Probing the final mass loss phase of AGB stars; a pilot study of Galactic Disk objects in the southern hemisphere"

083.D-0484(A) UT3 VIMOS
Apr 27, 2009 Apr 30, 2009, 1.5 nights
Visitor Mode

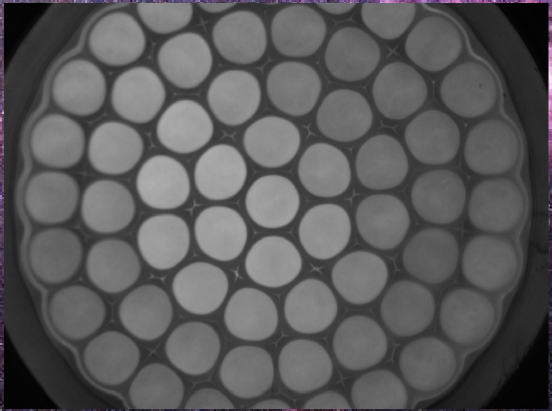

VIRUS @ HET

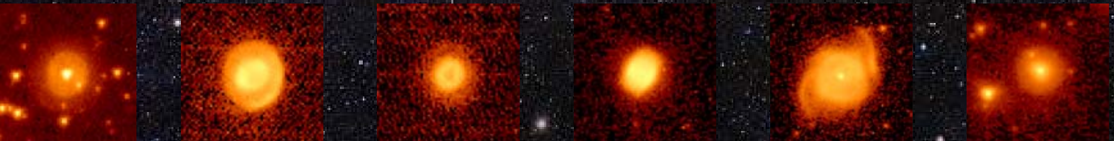
(5) LMC/SMC FIREBALL Survey



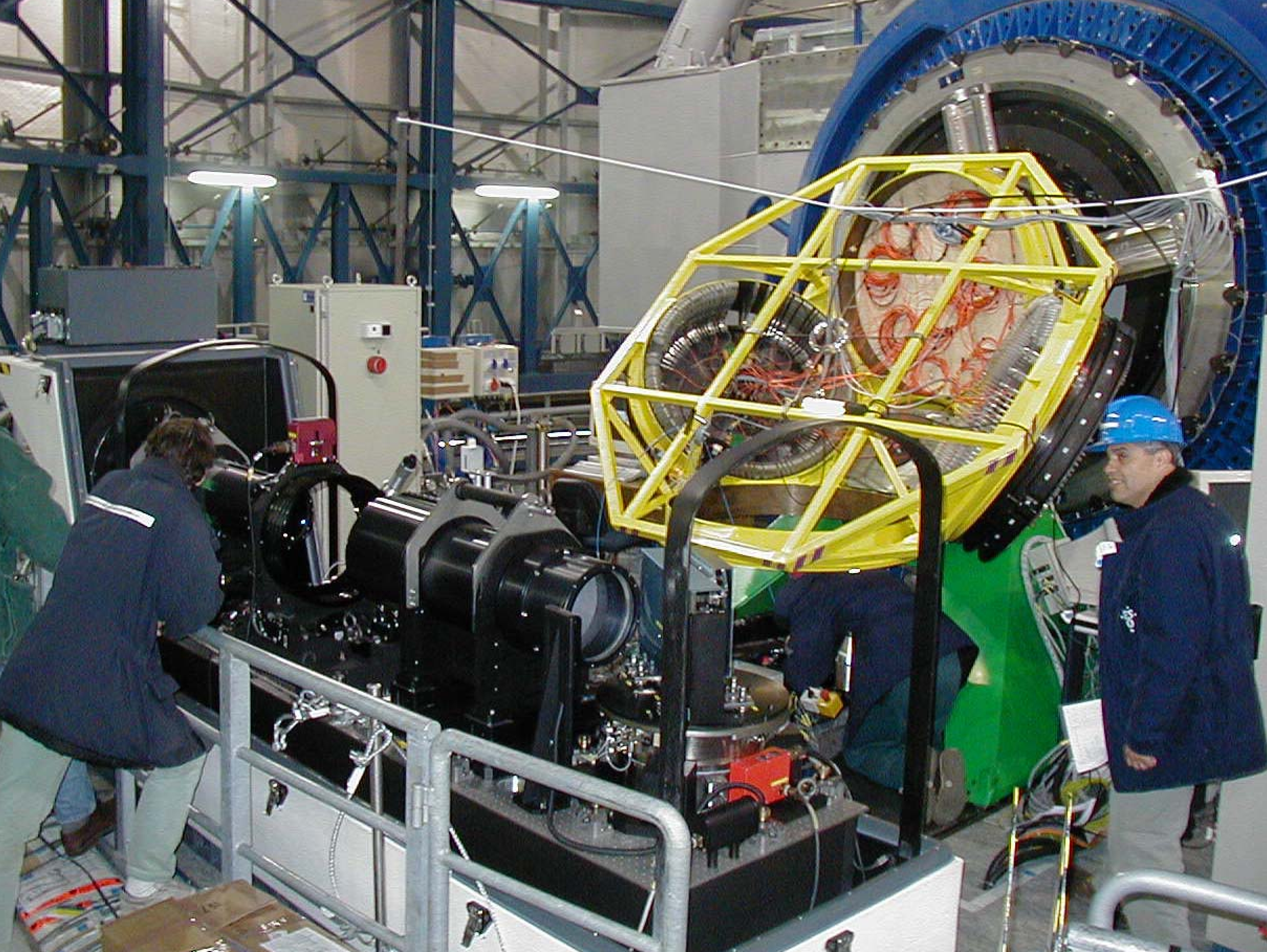


MG 40





credit: MCPN Team STScI



FIREBALL: proposal for an upgrade of FLAMES at VLT
AAO/USyd, Lyon, Potsdam

Instrument specification:

- 0.42"/core (set by retaining MUSE spectral resolution)
- 4.0-4.6"/hexabundle (max. field set by the button size)
- 50-75 hexabundles
- 60-90 fibre cores per hexabundle
- 5 MUSE spectrographs: 480(goal:430)-930nm, R=1500 @ 480nm, R=3600 @ 930nm.

Sensitivity:

- R~19.0-19.7 survey limit gives 50-100 galaxies per VLT field (median redshift ~ 0.2); typical scale sizes for disk galaxies are 2"-6" diameter (half light).
- Median surface brightness at z~0.2 is 23.5 mag/arcsec**2.

(5) Summary

- radiation-hydrodynamical models capable of describing observed PN structure
- use IFU to boost S/N on low-surface brightness regions and thus measure AGB mass loss history
- Calar Alto pilot study successful (highlight @ A&A)
- Feasibility study scheduled at VLT-VIMOS
  → future Large Program
- Goal: build and use deployable IFU upgrade for FLAMES to perform MOS on LMC/SMC PNe

[1]MESS: Herschel Key Project (GTO)

„The circumstellar environment in post-main-sequence objects"

The main aims of this programme are three−fold: (1) to study the time dependence of the mass loss process, via a search for shells and multiple shells around a wide range of evolved objects, in order to quantify the total amounts of mass lost at the various evolutionary stages of low to high−mass stars, (2) to study the dust and gas chemistry as a function of progenitor mass, and (3) to study the properties and asymmetries of evolved star envelopes.

To this end, a sample of 103 Asymptotic Giant Branch and Red Super Giants, post−AGB and Planetary Nebulae, Luminous Blue Variables and Wolf−Rayet stars, and 5 Supernovae remnants will be imaged with PACS at 70+170 micron, and a sub−set of 32 stars will be imaged at all 3 wavelengths with SPIRE.

In spectroscopy, a sample of 55 stars will be observed over the full wavelength range of PACS and, 23 stars will be observed with the SPIRE FTS.