3D-NTT (3D-4M)
A new instrument for the NTT based on versatile Tunable Filter technology

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on behalf of the 3D-NTT consortium:

Marseille (LAM): Amram, Balard, Boselli, Boulesteix, Buat, Cuby, Epinat, Gach, Joulié, Russeil
Paris (GEPI): Balkowski, Flores, Garrido, Hammer, Jagourel, Jégouzo, Proust, Sayède
Canada (LAE Montréal): Carignan, Chemin, Daigle, Denus Baillargeon, Hernandez
Australia (AAO): Bland-Hawthorn, Jones
Austria (Vienna): Zeilinger
Brasil (Sao Paulo): Fuentes-Carrera, Mendes de Oliveira & (Santa Cruz): Plana
Denmark (Copenhagen): Fynbo
Finland (Ulu): Laurikainen
France (CEA): Duc **& (Strasbourg):** Vollmer
Germany (ESO): Pompei **& (Bochum):** Bomans, Dettmar
Italy (Padova): Bettoni, Buson, Giro, Marziani, Mazzei, Rampazzo
Spain (IAA, Granada): Masegosa, Verdes Montenegro, Vilchez **& (IAC, Canarias):** Cepa
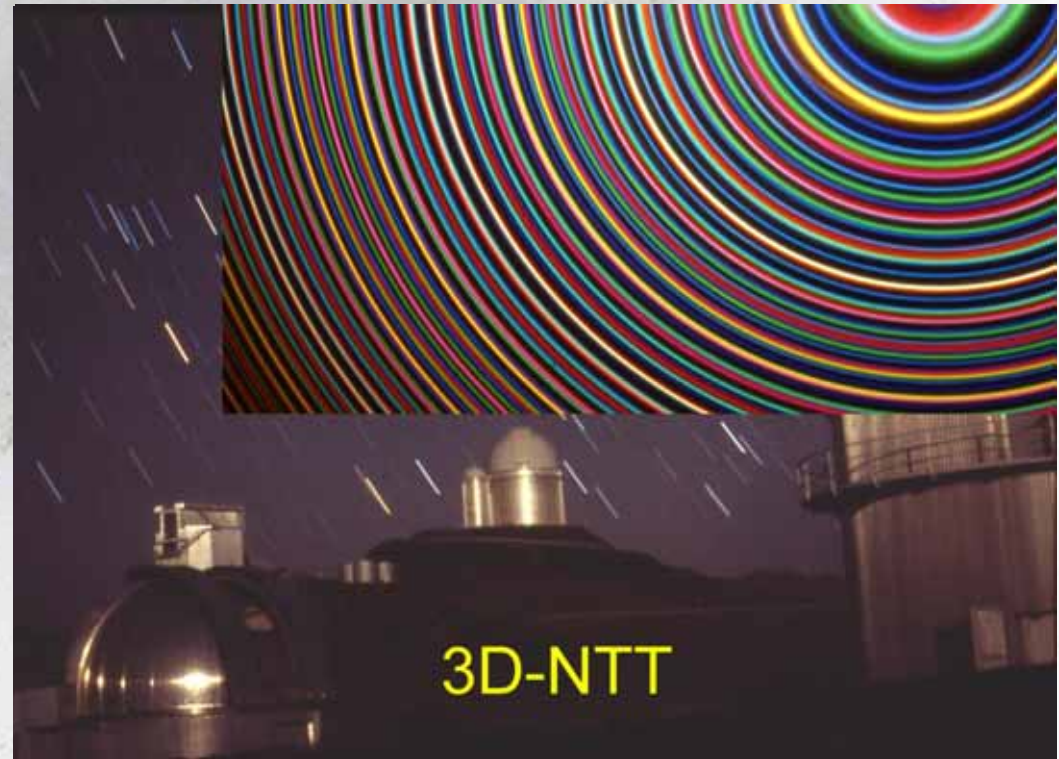**Sweden (Uppsala):** Bergvall, Östlin, Marquart
USA (Tuscaloosa, Alabama): Sulentic

What is the 3D-NTT ?

A visitor instrument (visible spectro-imager) to be placed at the Nasmyth focus of the NTT

Focal reducer with two modes:

- Low resolution
(100 – 5 000)
Tunable Filter

- High resolution
(5 000 – 40 000+)
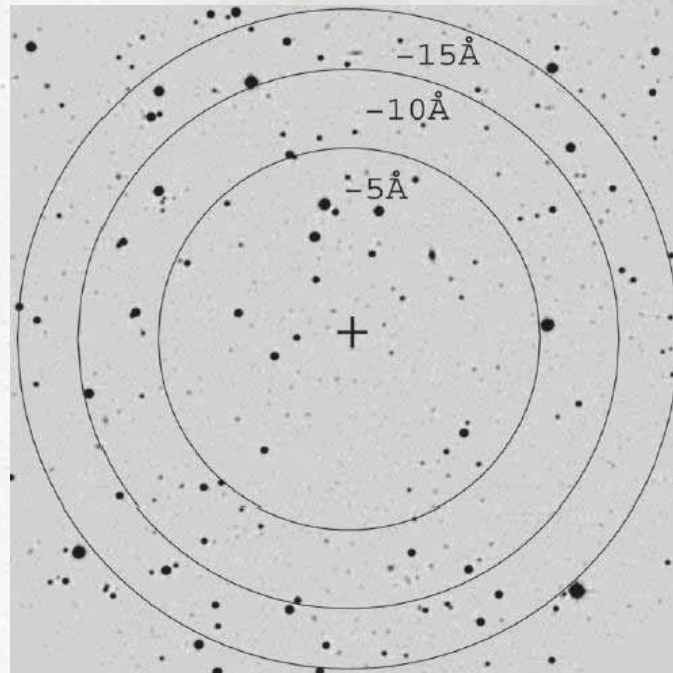Scanning Fabry-Perot

What is new with our Tunable Filter ?

- Long excursion piezo-actuators (400 μm)
  cover of a wide range of interference orders
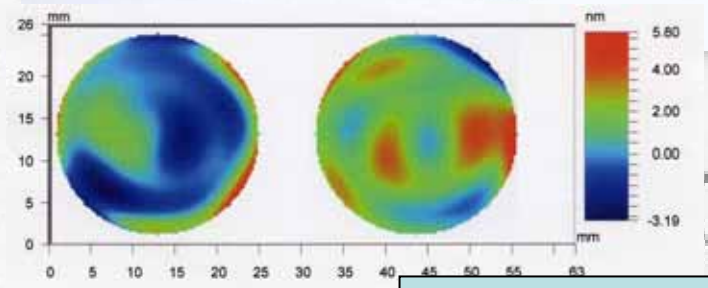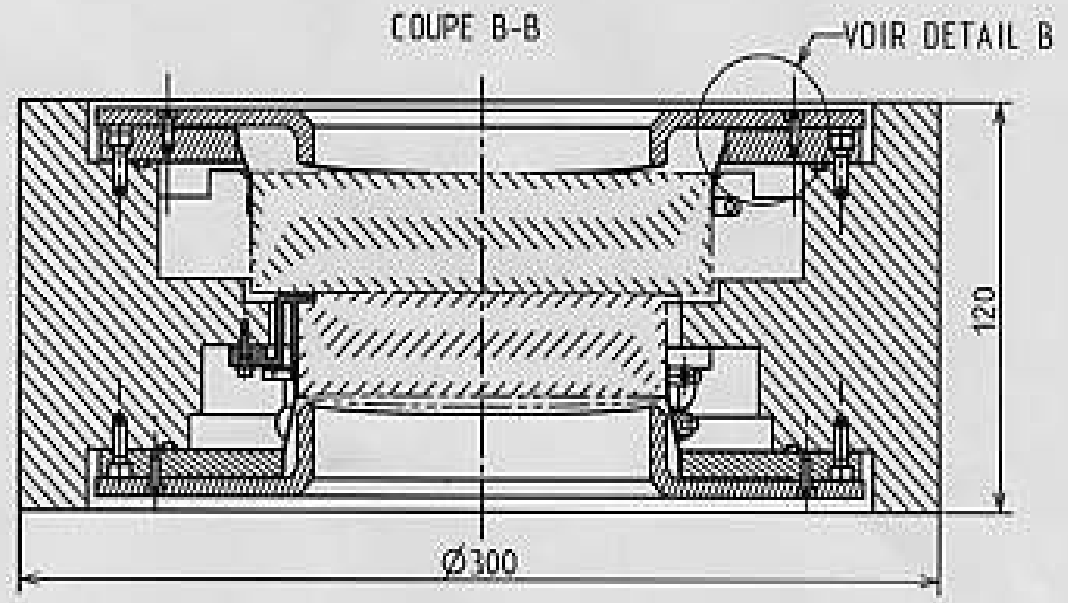 Same device:
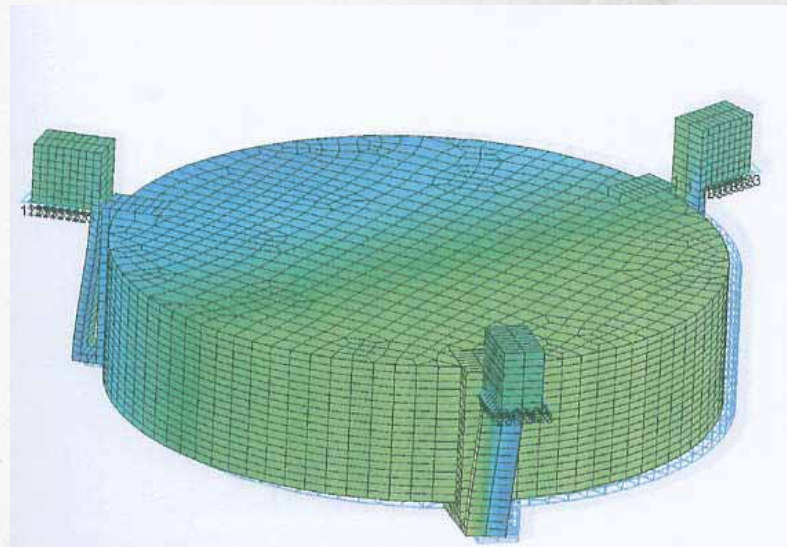 - Tunable Filter
  - Scanning Fabry-Perot

- It will be placed
  in the focal plane
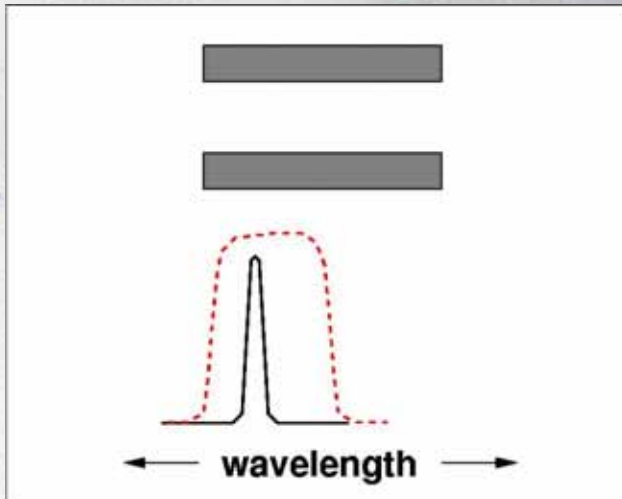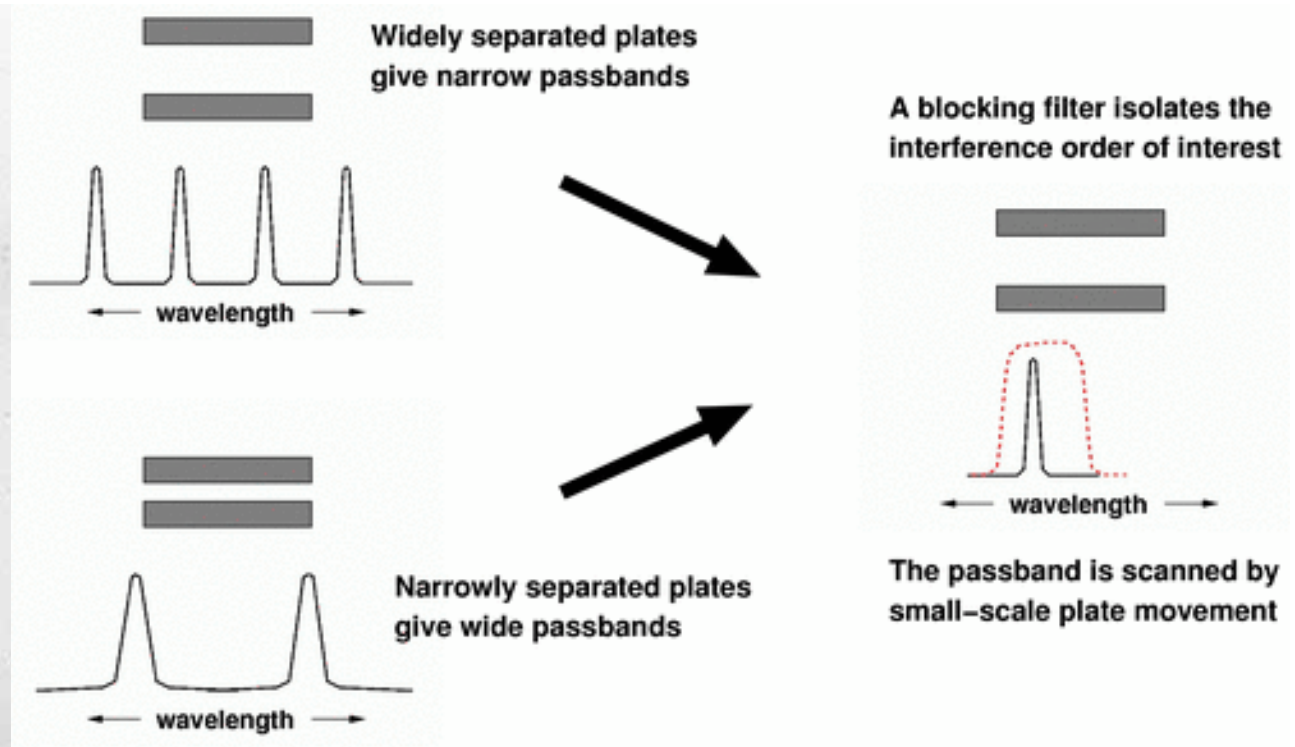
No phase shift across the field

Can be used as an interference filter for
the 2nd scanning Fabry-Perot (HR mode)

private companies
(SESO, CEDRAT, FOGALE,
SHAKTIWARE)

public laboratories
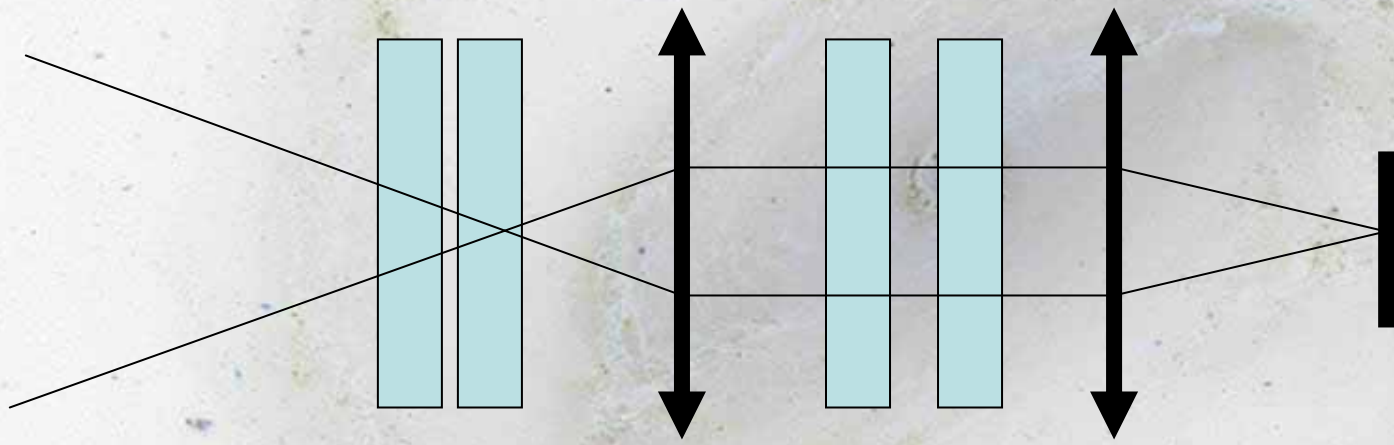(OAMP/LAM and Fresnel Institute).
Ready: end 2006

Tuning a Fabry-Perot

Widely separated plates give narrow passbands

wavelength

Narrowly separated plates give wide passbands

wavelength

A blocking filter isolates the interference order of interest

wavelength

The passband is scanned by small-scale plate movement

wavelength

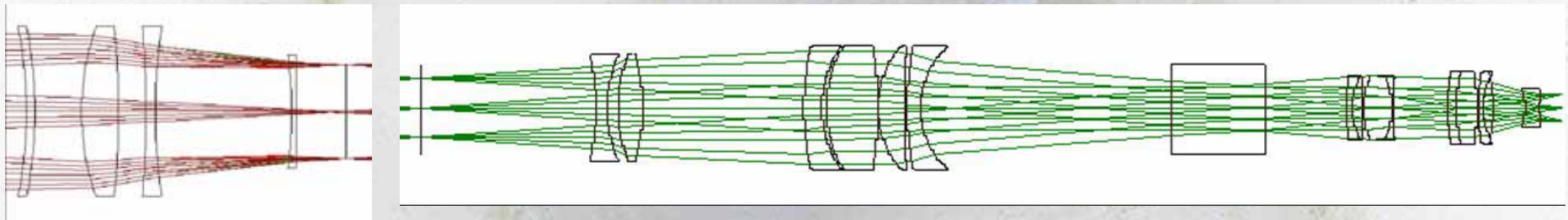# Optical concept of the 3D-NTT

Low order FP

(Tunable Filter)

High order FP

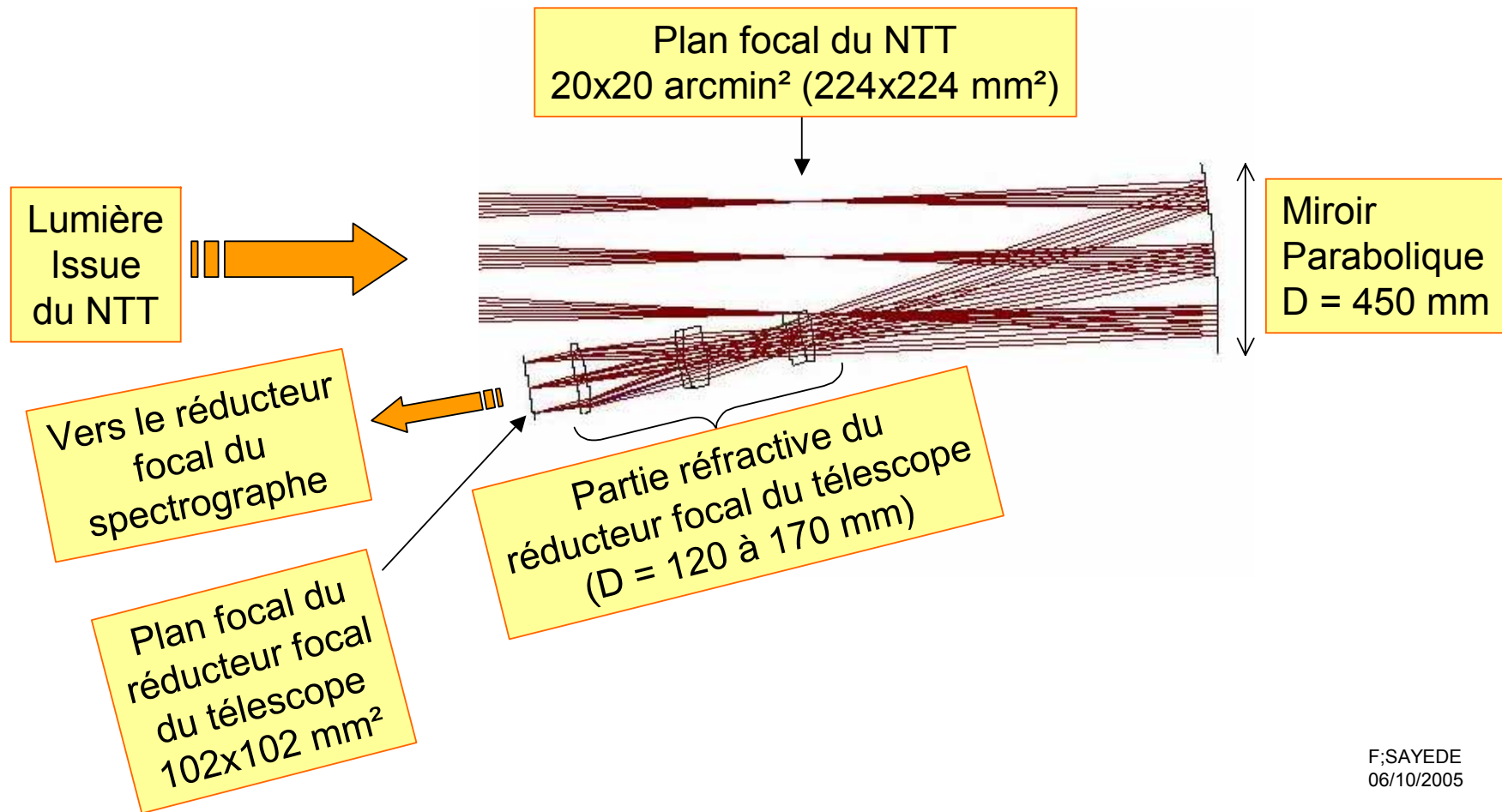# Instrument Planning
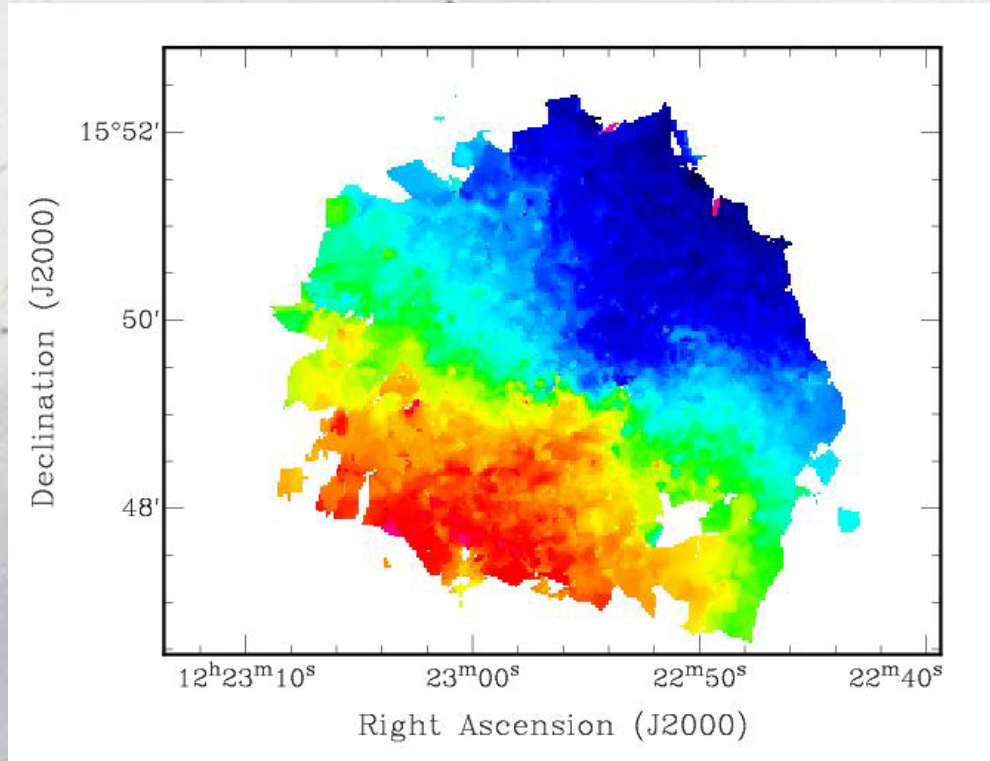
3D-NTT

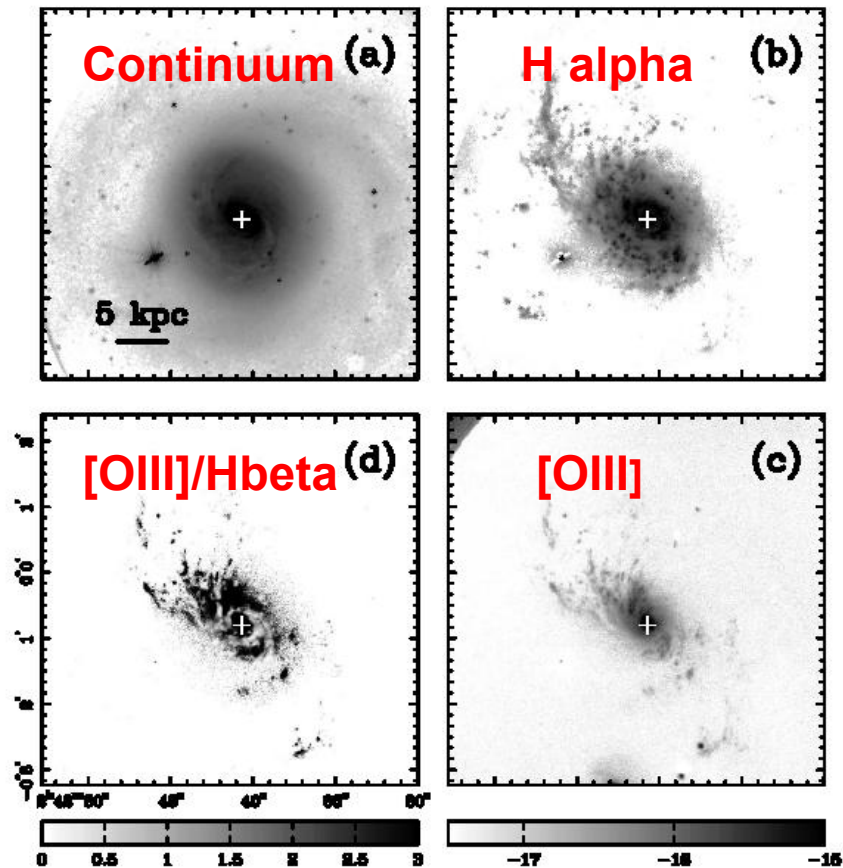GEPI (optical design)

   – LAM + GEPI (mechanical design)

     Complete design ready: mid-2006

Making of the instrument : 2007 → ready to observe : end of 2008

REDUCTEUR FOCAL DU TELESCOPE POUR LA SOLUTION « GRAND CHAMP »

Plan focal du NTT
20x20 arcmin² (224x224 mm²)

Lumière Issue du NTT

Miroir Parabolique
D = 450 mm

Vers le réducteur focal du spectrographe

Partie réfractive du réducteur focal du télescope
(D = 120 à 170 mm)

Plan focal du réducteur focal du télescope
102x102 mm²

F;SAYEDE
06/10/2005

The 3D-NTT will be a **powerful** tool for studying the **ionized gas in galaxies and IGM**

Continuum (a)

H alpha (b)

[OIII]/Hbeta (d)

[OIII] (c)

5 kpc
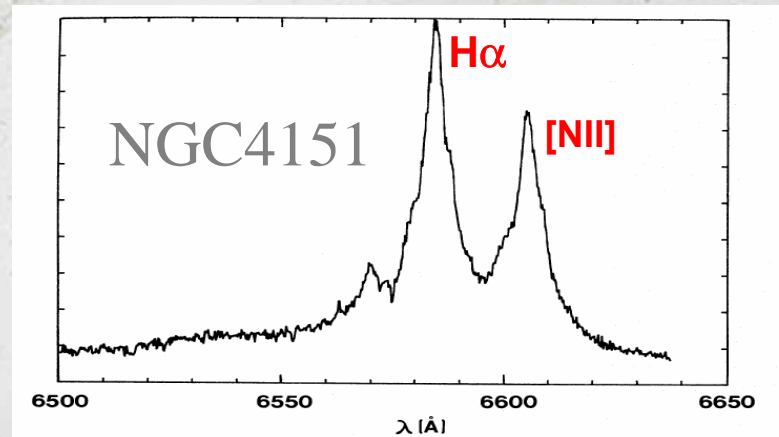
NGC1068
TTF

(Veilleux
et al. 2003)

M100, Daigle et al., 2006

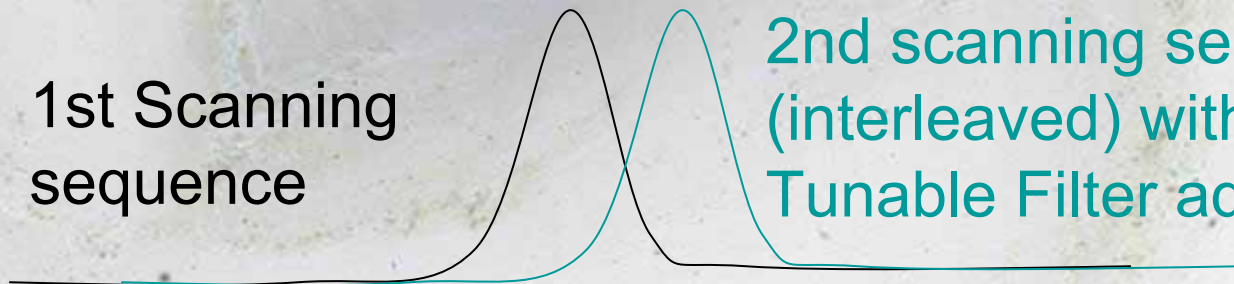*Low Resolution mode*   *High Resolution mode*

Focus on the study of the **evolution of galaxies complementary** of **VLT** observations

The Tunable Filter :
a powerful tool for measuring line ratios

NGC4151

Hα

[NII]

6500   6550   6600   6650

λ (Å)

1st Scanning
sequence

2nd scanning sequence
(interleaved) with
Tunable Filter adjusted

IOGA

IOnized gas in star forming Galaxies through the Ages

A) Survey of 500 IR galaxies
- mapping the SFR and kinematics (HR mode)
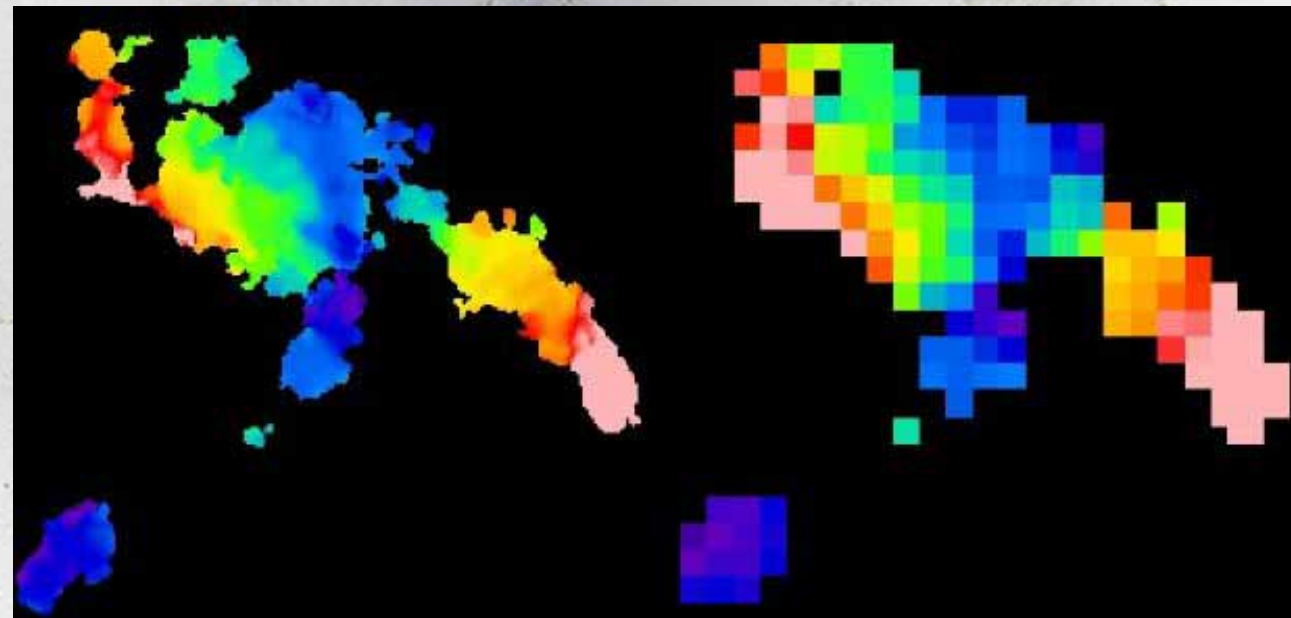- mapping the dust extinction, metal abundances and electron density for 50 LIRGS (LR mode)

➡ provide a **reference sample** with high spectral and spatial resolution (sub-kpc)

➡ **comparison** with distant objects on the VLT (GIRAFFE, SINFONI)
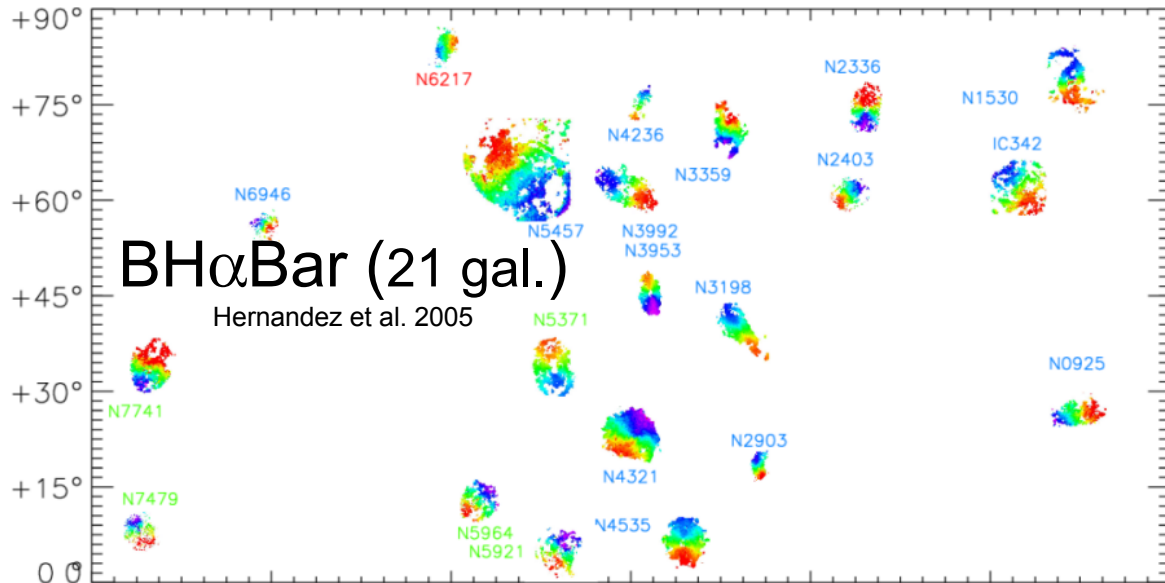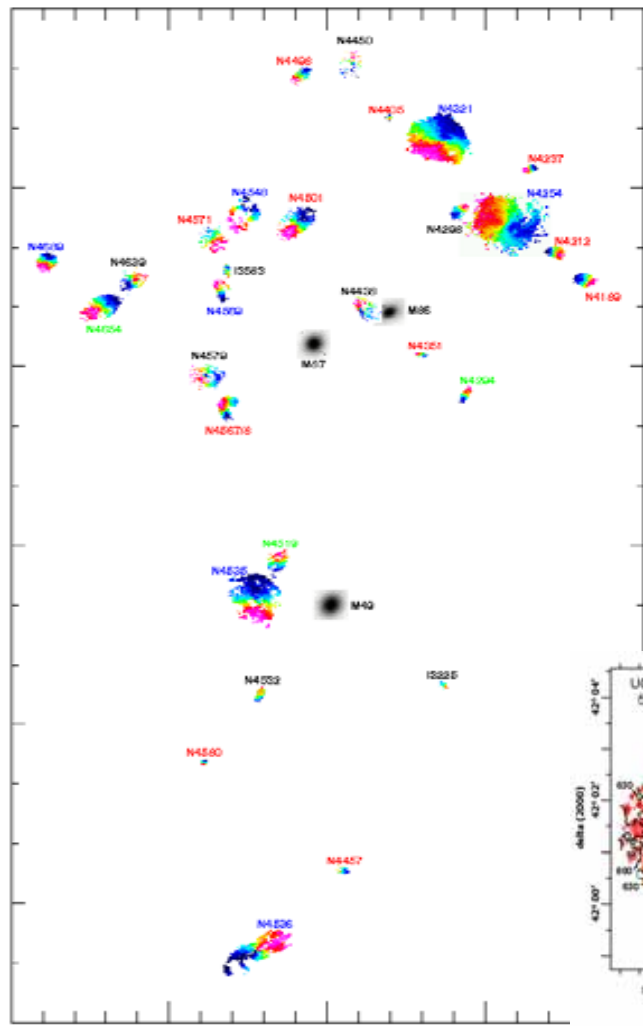

HCG31

velocity field

(Amram et al. 2004)

observed with ESO 3.6m   as seen at z~0.5
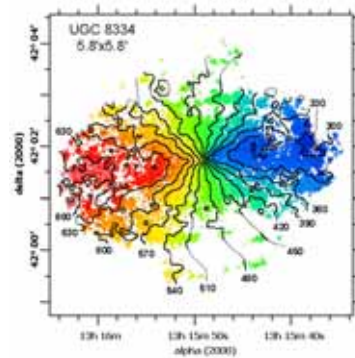
VIRGO (30 gal.)
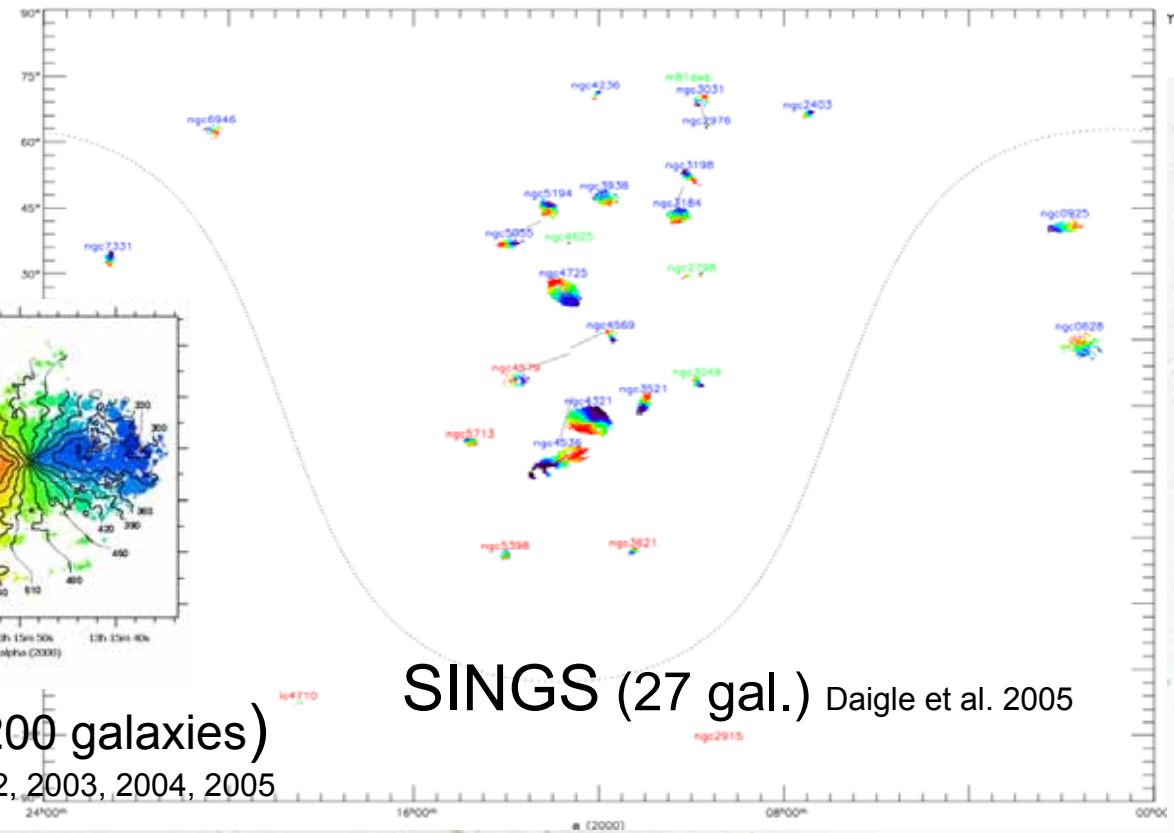Chemin et al. 2005
See poster n° 2 (Chemin et al.)

BHαBar (21 gal.)
Hernandez et al. 2005

N6217
N2336
N1530
N4236
N3359
IC342
N6946
N2403
N5457
N3992
N3953
N3198
N5371
N0925
N7741
N2903
N7479
N4321
N5964
N5921
N4535
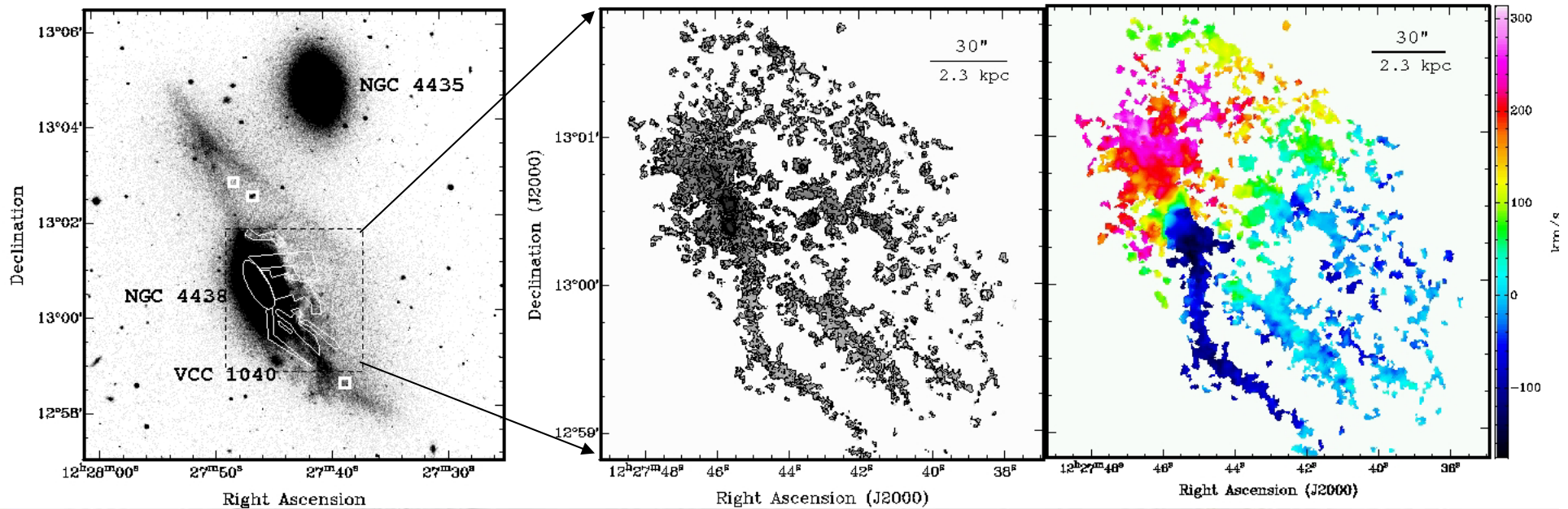
GHASP (200 galaxies)
Garrido et al. 2002, 2003, 2004, 2005

UGC 8334
5.8'x5.8'
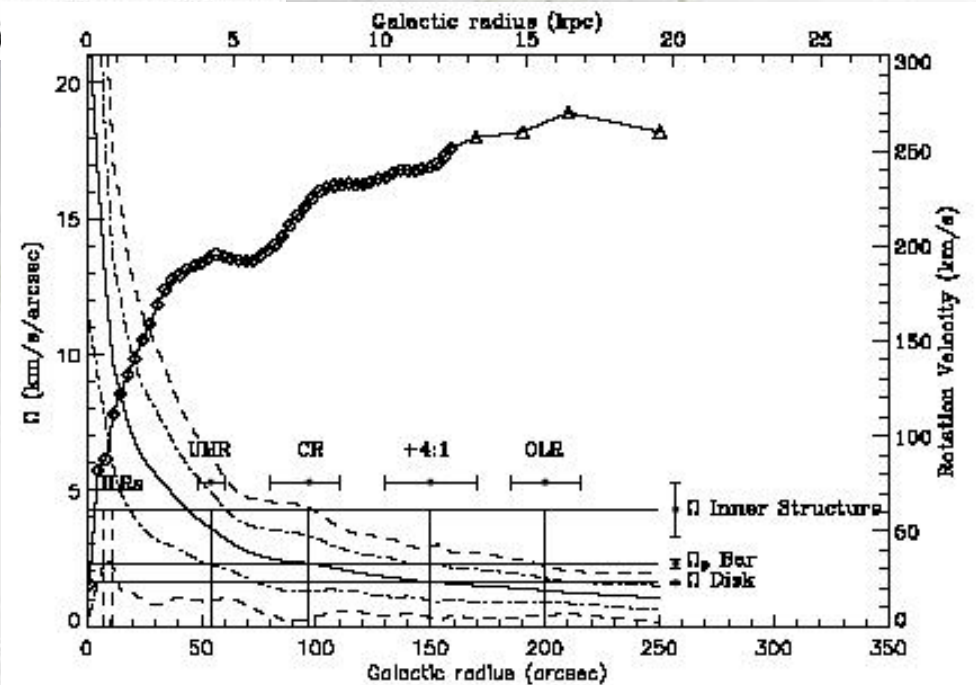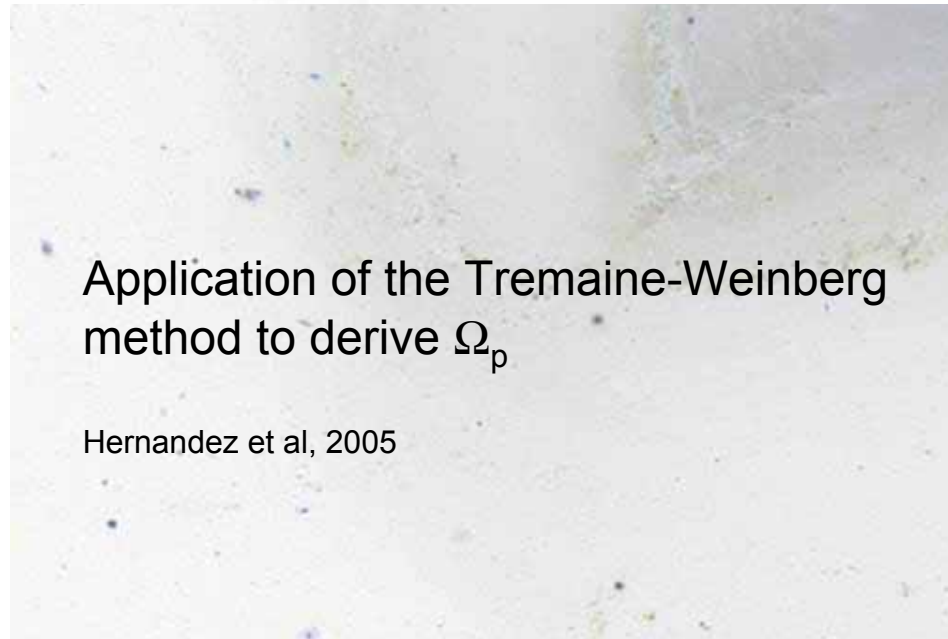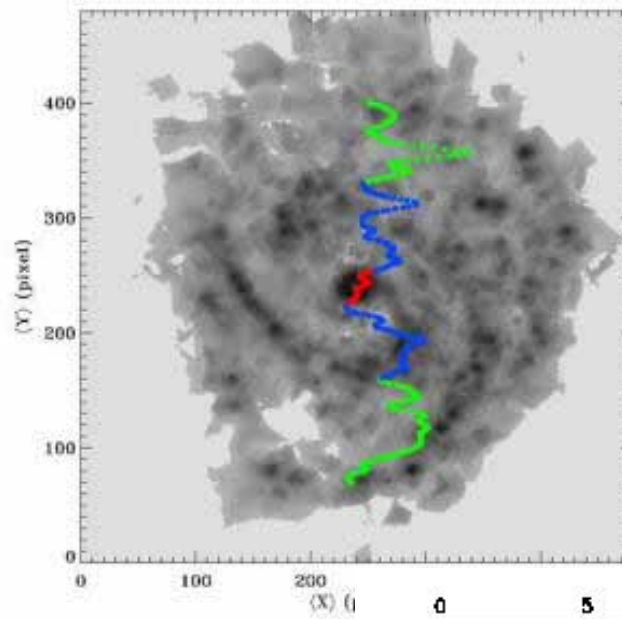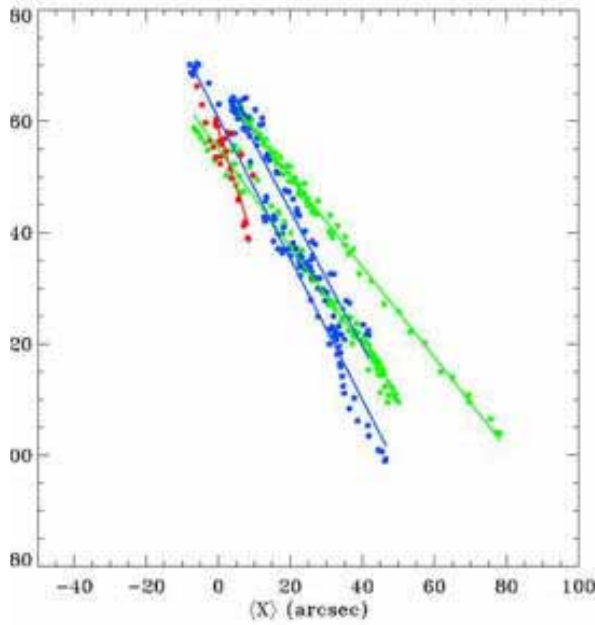
SINGS (27 gal.) Daigle et al. 2005

High Resolution mode: Virgo Cluster

(Chemin et al, 2005)

NGC 4438 = Prototype of a galaxy interacting with ram pressure stripping and companion

High Resolution mode: From 2D-kinematics to dynamics

Application of the Tremaine-Weinberg method to derive Ω_p

Hernandez et al, 2005

Low Resolution Mode (Tunable Filter)

Example of metal abundance map obtained with a Tunable Filter

NGC1365 observed with the TTF on the AAT (Veilleux et al. 2003)
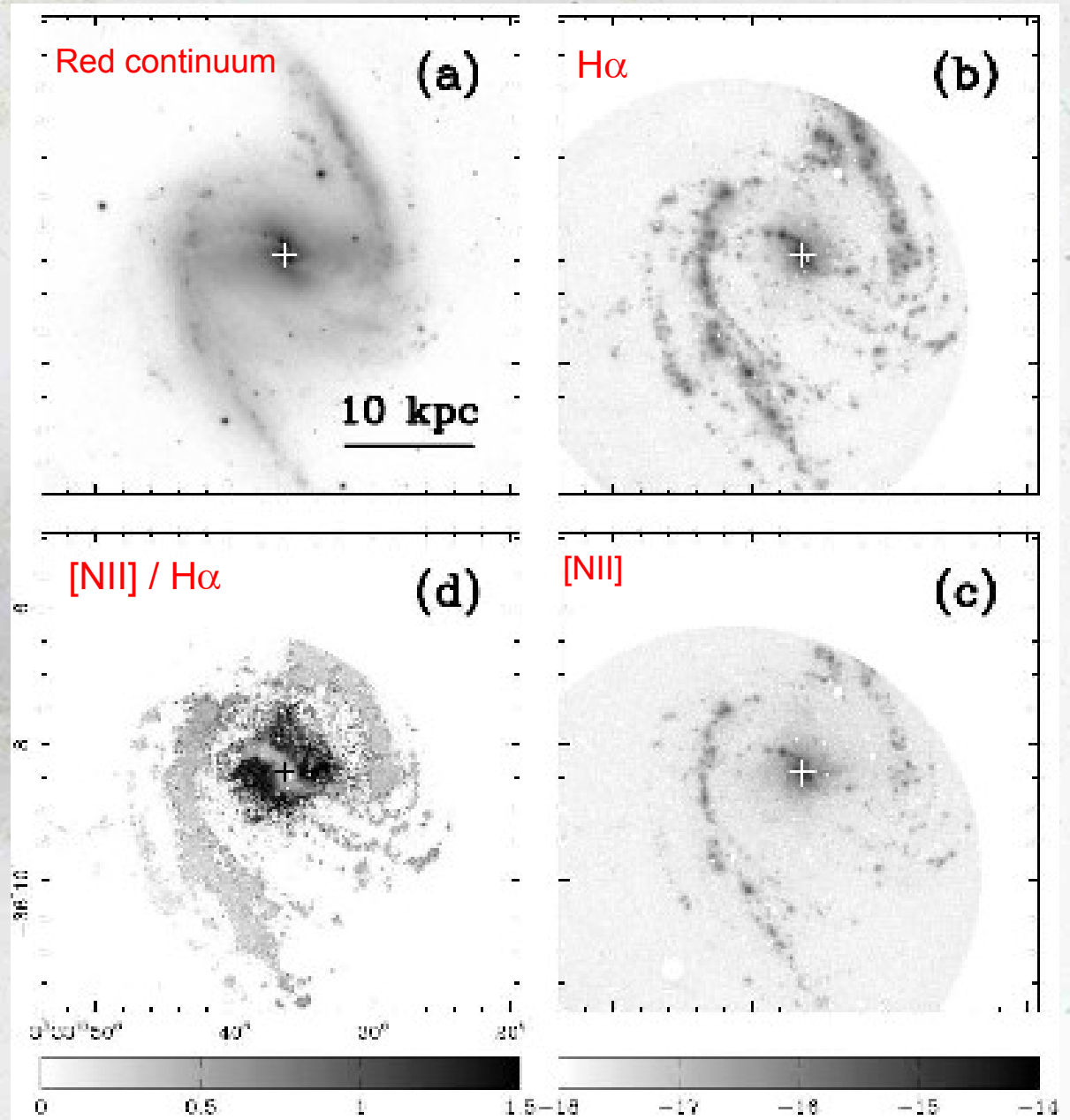
IOGA

B) Survey of a sample of 50 quasars at z ~2

? Are there ELGs around distant and luminous quasars
(Francis and Bland-Hawthorn, 2004).

? Powerful UV fields can suppress or delay widespread star formation in galaxies

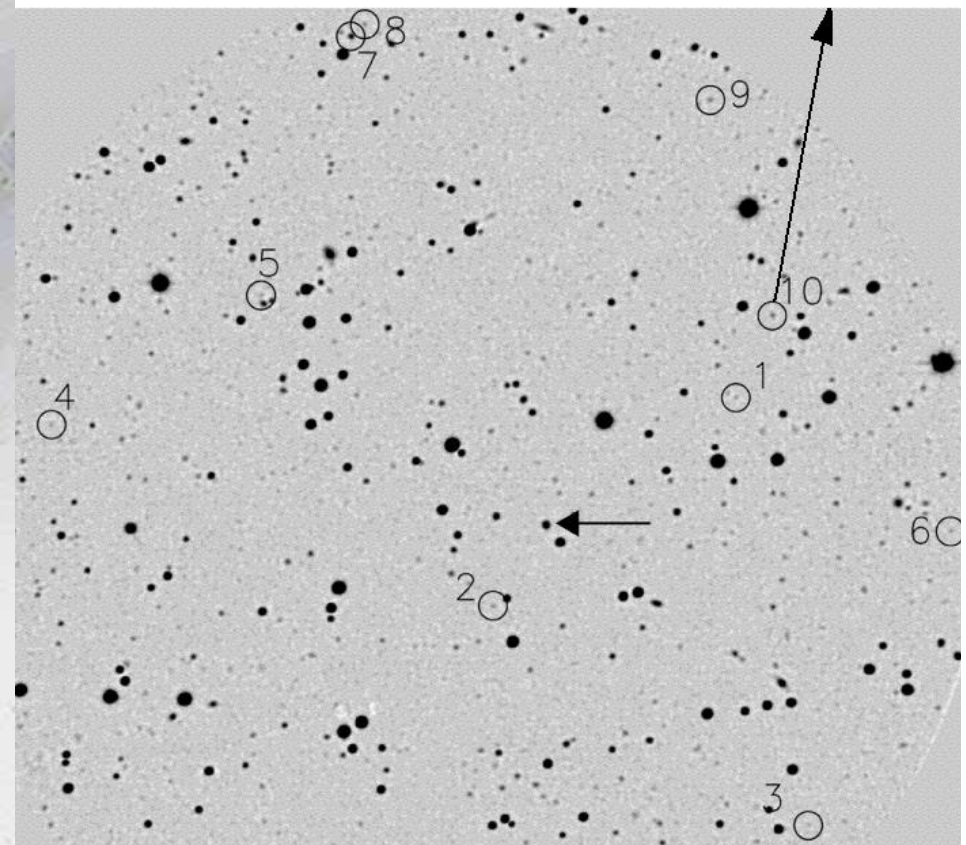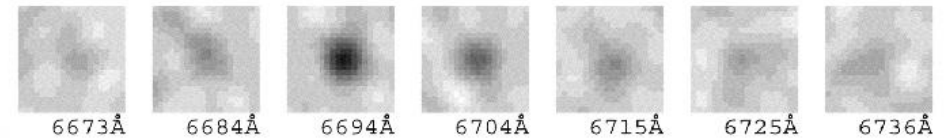→ **constraints**
on cosmological models

Detection of ELGs around QSO at z=0.8
TTF, FOV = 7'x7' (Barr et al. 2004)
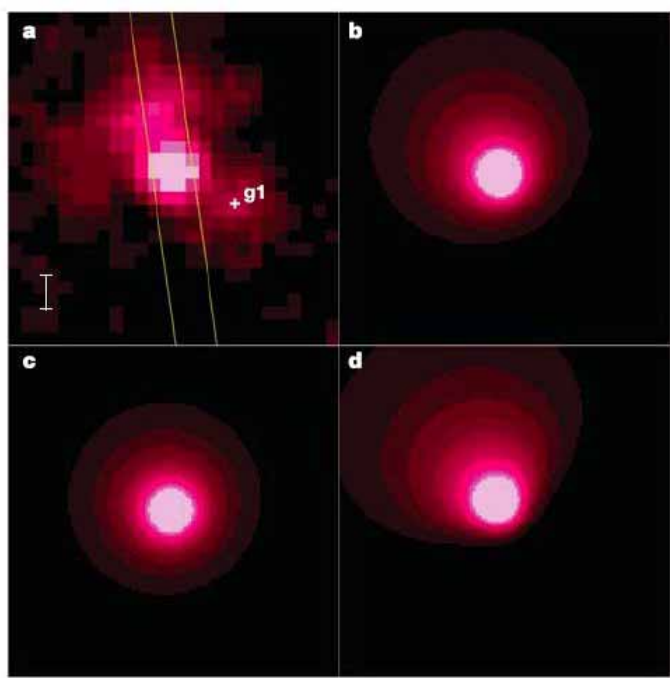
Ly α ionization cone (Weidinger et al. 2004)

MRC B1359−281, ID 10, [OII] = 6716Å

6673Å 6684Å 6694Å 6704Å 6715Å 6725Å 6736Å

Key-programs with 3D-NTT

In Tunable Filter mode :
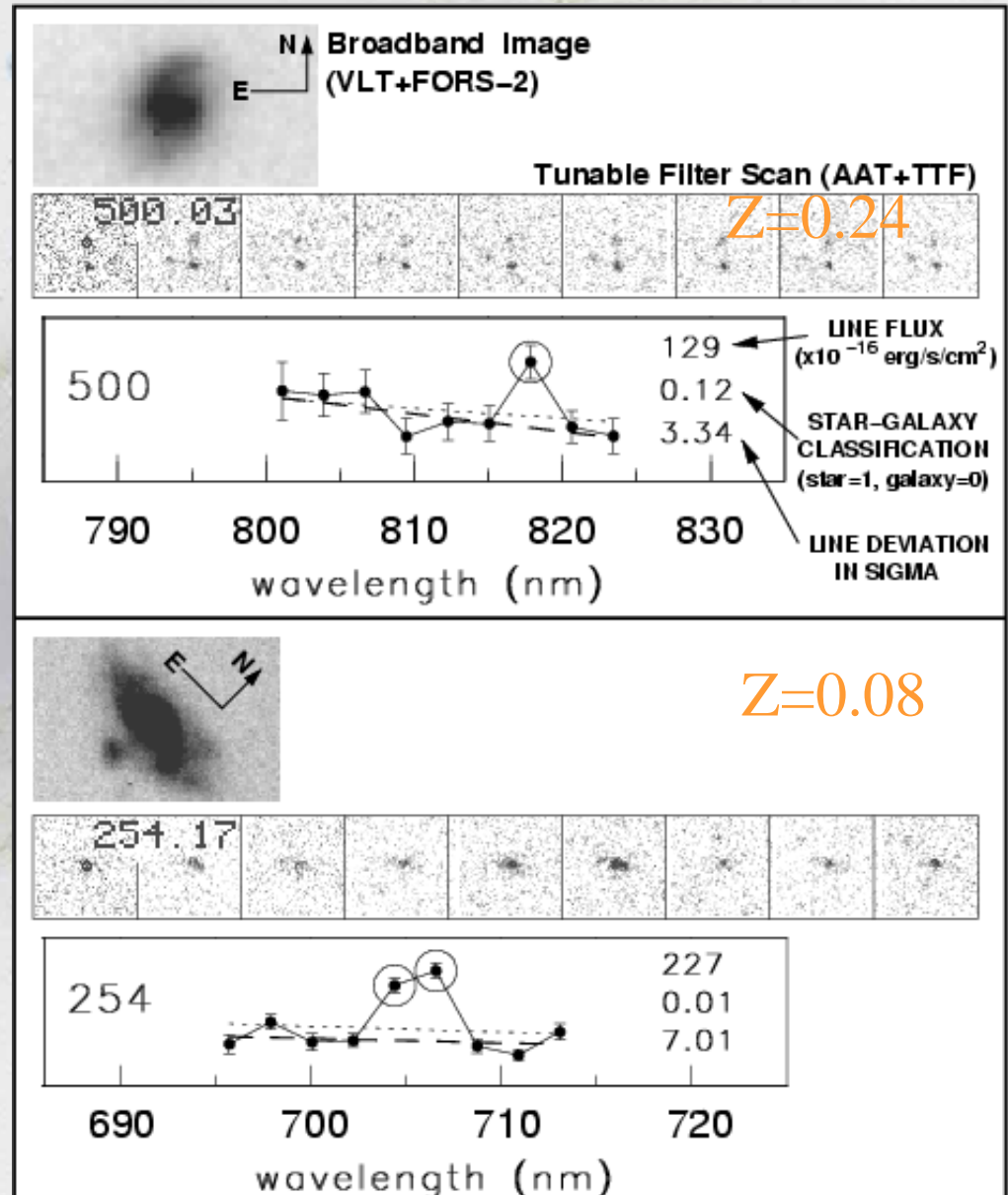pre-selection of VLT targets

Survey of the SFR in galaxies at different redshifts
(e.g. Jones et al. 2001 with AAT) →

Also :

Detection of redshifted Lyman Alpha of primeval galaxies
(to be confirmed by follow-up spectroscopy with the VLT)

Other possible programmes
(from 3D-NTT Workshop, Marseille, June 16-17th 2005)

Follow up of other surveys at different wavelengths like:
- Line maps (SINGS/Spitzer & AMIGA)
- Accretion & galaxy evolution in poor groups

Nearby galaxies
- Low-z super-wind galaxies and of shocked gas
- Galactic winds of dwarf irregular galaxies
- Mapping the large scale potential wells of galaxies using PN
- Search for warm ionized gas around nearby radio galaxies
- Identification and Mapping of star forming galaxies

AGN
- Seyfert 2 and LINERS as well as filamentary ionized structures in clusters
- Study of ionization cones and unification models of AGN

Clusters
- Ionized gas in intracluster medium

Distant galaxies
- Search for high-redshift gravitationally lensed galaxies

Data reduction and Data Base

Data from the 3D-NTT will be put in public access in that Data Base 1 year after the observations

Main characteristics of the 3D-NTT

	TUNABLE FILTER MODE	**HIGH RESOLUTION MODE**
Field of view	20' x 20'	11' x 11' or 5.5' x 5.5'
Wavelength range	350nm to 850nm (a)	500nm to 800nm (b)
Interference order	tunable from 4 to 100 (at Hα) (*indeed from 4 to 1200*)	tunable from 100 to 1 200 (at Hα) (*indeed from 4 to 1200*)
Detector	CCD (4k x 4k with 15µm pixels)	IPCS 25mm AsGa (1k x 1k with 17µm pixels)
Scale	0.29"/pixel	0.52"/pixel or 0.34"/pixel dep. on FOV

(a): range of a standard thin blue sensitive CCD (to reach the 3727 Å [OII] line)

(b): range limited by sensitivity of AsGa photocathode

Comparison with other TF instruments

TTF	AAT & WHT	1996 - 2003	3.9m	9'	50 nights/year
MMTF	Magellan	Dec. 2005	6.5m	27'	7 nights/year
OSIRIS	Grantecan	June 2006	10m	6.7'	100 nights/year (OTELO)
3D-NTT	NTT	End 2008	3.5m	20'	37 (IOGA)

3D-NTT can see the [OII] line at 3727Å (not the case for MMTF)

N.B. all of these TF suffer from phase shift effect (in the pupil) ***except 3D-NTT***

Conclusion

The 3D-NTT

- **Large Programme (IOGA) - survey of 500 IR galaxies (LR and HR modes)**

  complementary of VLT observations at high z

  - survey of 50 quasars (detections of ELGs and imaging DM halos)

- **Other possible programmes (Follow-up of other surveys, nearby galaxies, AGN, clusters, distant galaxies…)**

Spectro-imager with resolution ranging from 100 to 40 000 in the visible

Perfect selection of the scanned line (both devices being scanned synchronously)

Powerful TF mode   - no phase shift effect

- blue sensitivity (down to 350 nm)

- large field of view (20 arcmin)