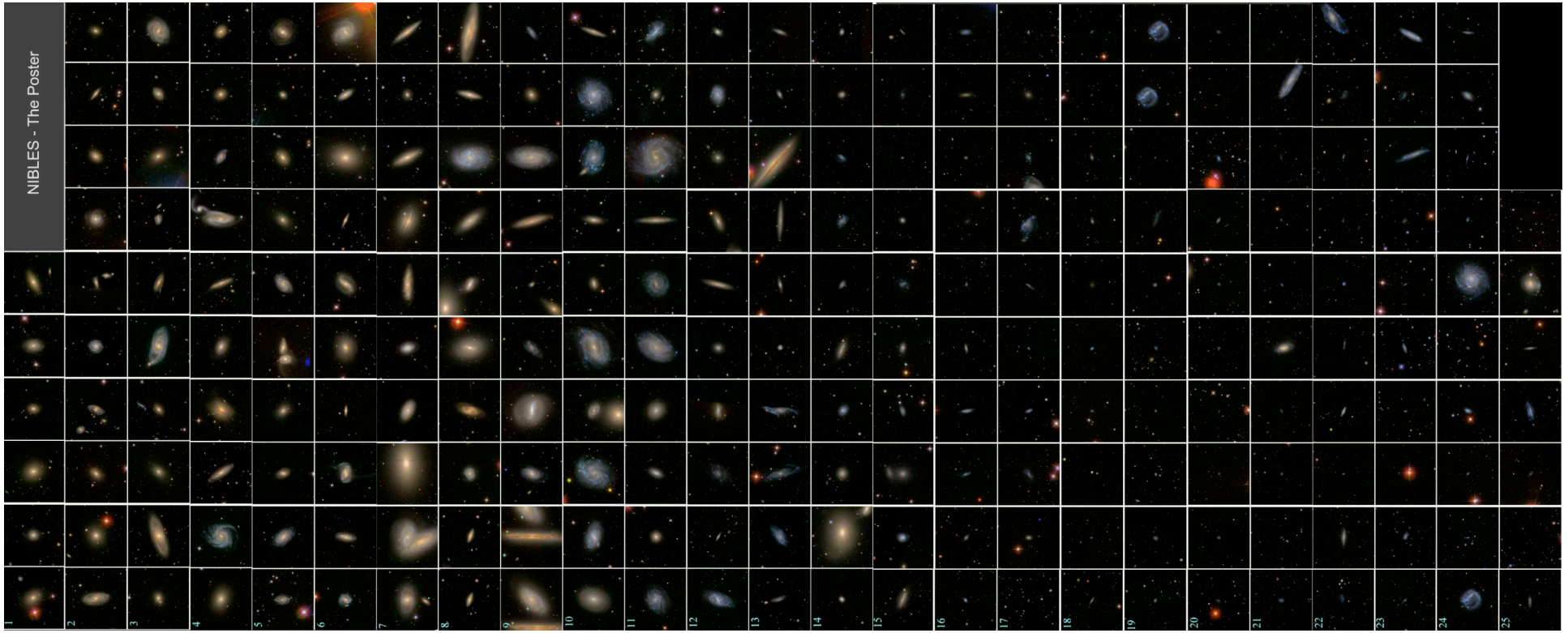
NIBLES – an HI census of local SDSS galaxies

Wim van Driel
Paris Observatory



PRA2009, Groningen, 02/06/09

Nançay Interstellar Baryons Legacy Extragalactic Survey

30+ NIBLErS:

Steve Schneider (UMASS), Matt Lehnert (Paris Obs.)

Present at PRA 2009:

Erwin de Blok, Sarah Blyth, Antoine Bouchard, Renée Kraan-Korteweg,
Kurt van der Heyden: University of Cape Town
Laurent Chemin: Paris Observatory
Tom Oosterloo: ASTRON
Benjamin Winkel: Argelander Institute

Open collaboration!

Single-dish HI survey in the pre-SKA Precursors Era?

Strategic questions for the 100m-class Nançay Radio Telescope

In 2007:

Don't we already have enough published HI data?

Why to observe galaxies in HI with a 100m-class telescope,
while a 300m telescope (Arecibo) is doing blind HI galaxy surveys?

In 2009:

Continue HI observations once the SKA Precursors are unleashed in 2013?

Blind and pointed HI surveys – complementarity

Blind: complete survey of a limited space volume

Short integration per source, need high sensitivity/large field-of-view

Universe is basically empty → detections only few % of the time,

- Important for checking if classes of galaxies are missed in optical surveys, e.g., gas-rich low surface brightness (LSB) galaxies, but time-inefficient (few % on-source)

Pointed: survey of pre-selected objects

Longer integrations, can use a 100m-class telescope (NRT) to be competitive,

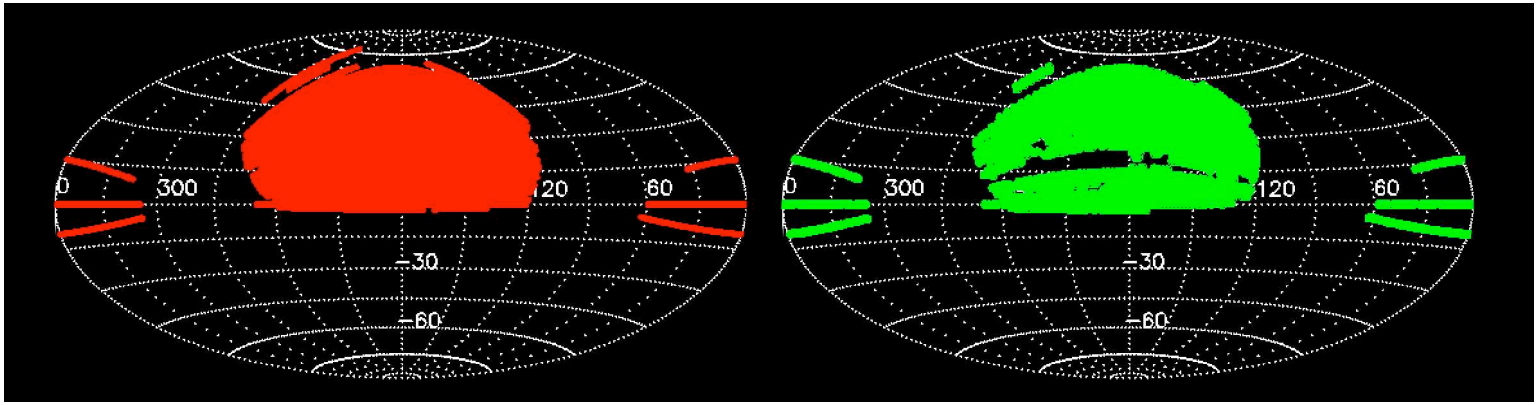
but need to know positions and redshifts of galaxies

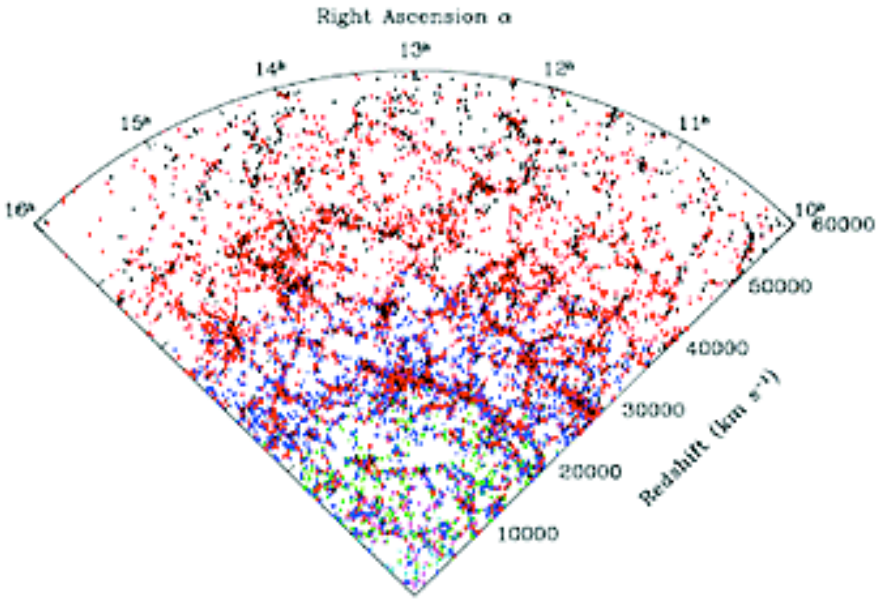
- An optical *blind* survey changes the game: Sloan Digital Sky Survey (SDSS) → time-efficient (50% on-source) for galaxy properties studies

Sloan Digital Sky Survey (SDSS) – present state

7000 square degrees ; 200 million objects; 800,000 spectra (stars to quasars)

Imaging → 5-band **photometry** Spectroscopy → **redshifts, gas metallicities**





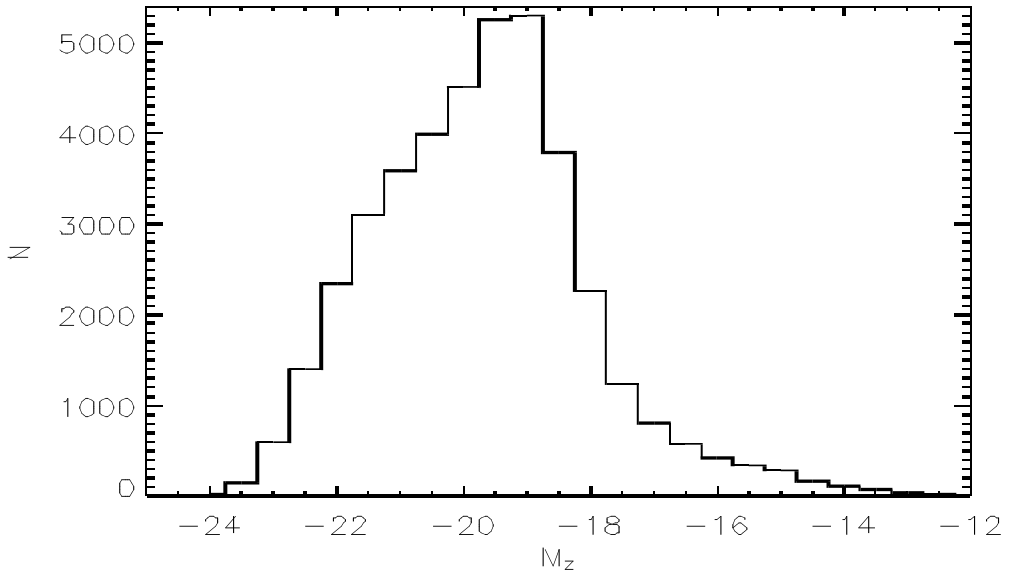
40,000 SDSS galaxies

with V<12,000 km/s

Towards a robust HI census of local galaxies - 1

Goal: determine the HI (and CO) properties of local galaxies
over the full width of their absolute magnitude distribution (12 mag):
stellar mass-based selection: z-band absolute magnitude

Can't we do this with the thousands of galaxies already detected in HI?



absolute magnitude in z-band (red)

40,000 SDSS galaxies

with V<12,000 km/s;

18,000 also have NIR:

only 8% detected in HI …

50% of which are gas-rich spirals
at M_z –20.5 to –23.5

Scientific justification - 1

- Star formation is the most fundamental driver of the properties of the ensemble of galaxies in the local Universe.
- The distribution of HI and H_2 gas over galaxy type and mass tells us how efficient the star-formation has been.
- Star formation yields: compare galactic gas fractions and metallicity, to determine the effective yields of the largest sample of galaxies available

- Compared to the stellar mass content, the HI + H_2 gas adds a further 20%, but there is an uncertainty of at least a 40% in the global HI + H_2 budget

- Complete and robust analysis of the baryon density in the local Universe, determine the phase in which these baryons reside ;
Co-moving space density of HI, H_2, stellar, and dynamical mass

- Determine the HI and CO Mass Functions, their joint probability distribution, correlations with other galaxy characteristics, e.g., total stellar mass, dynamical mass, infrared luminosity, morphological type, stellar age, average stellar density

NIBLES observation strategy

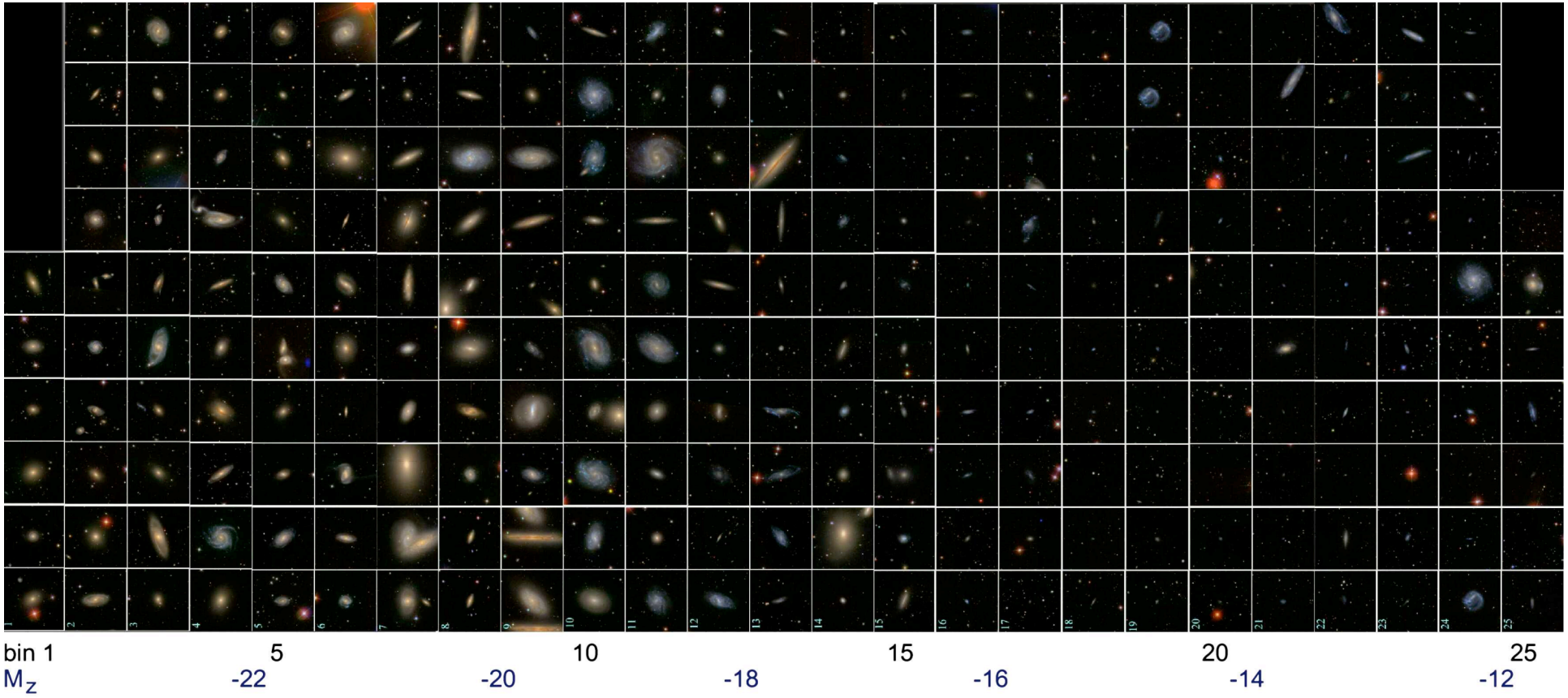
Goal: 3000 galaxies, finish (well) before end of ALFALFA (late 2009)
Standard at NRT: 1 hour/galaxy, gives 2 mJy rms

1. Start with 30/40 minutes per galaxy: rms 2.6 mJy
 - rms comparable to ALFALFA; but can cover δ -39° to +70°

2. Continue with longer (60 min) observations of non-detections in 2009
 - significantly better sensitivity than ALFALFA (1.6 mJy)
 - 50% of short non-detections now detected

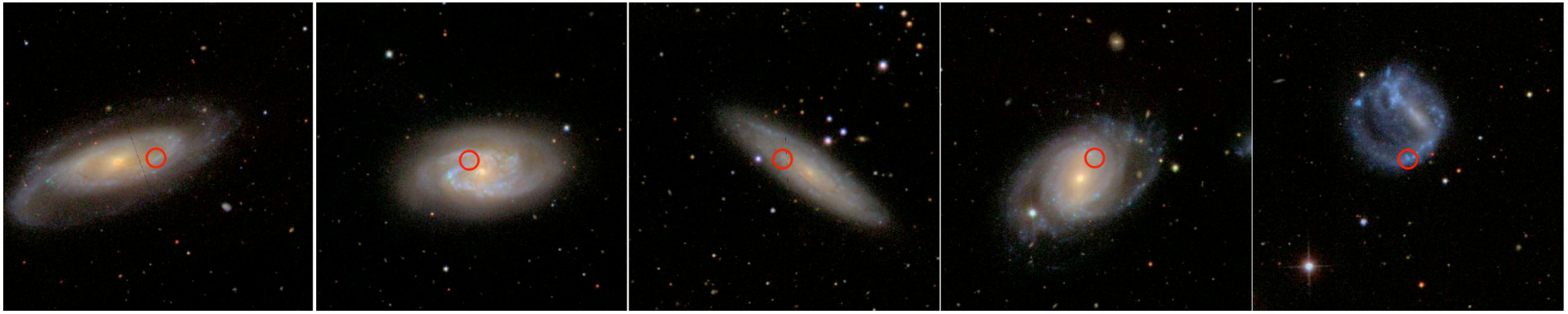
→ **expected overall detection rate of 75-80%**

NIBLES: meet the galaxies



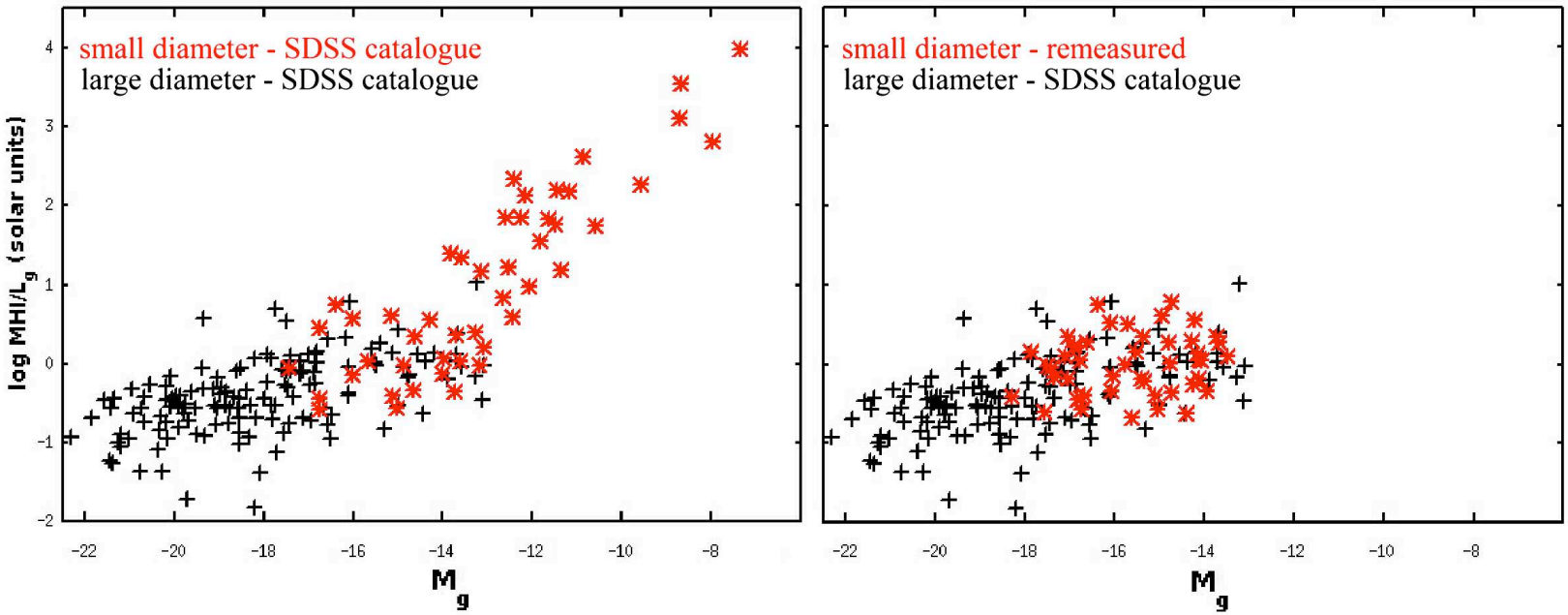
colour SDSS images of 250 galaxies, sorted per absolute magnitude

NIBLES: SDSS sources that are part of larger galaxies



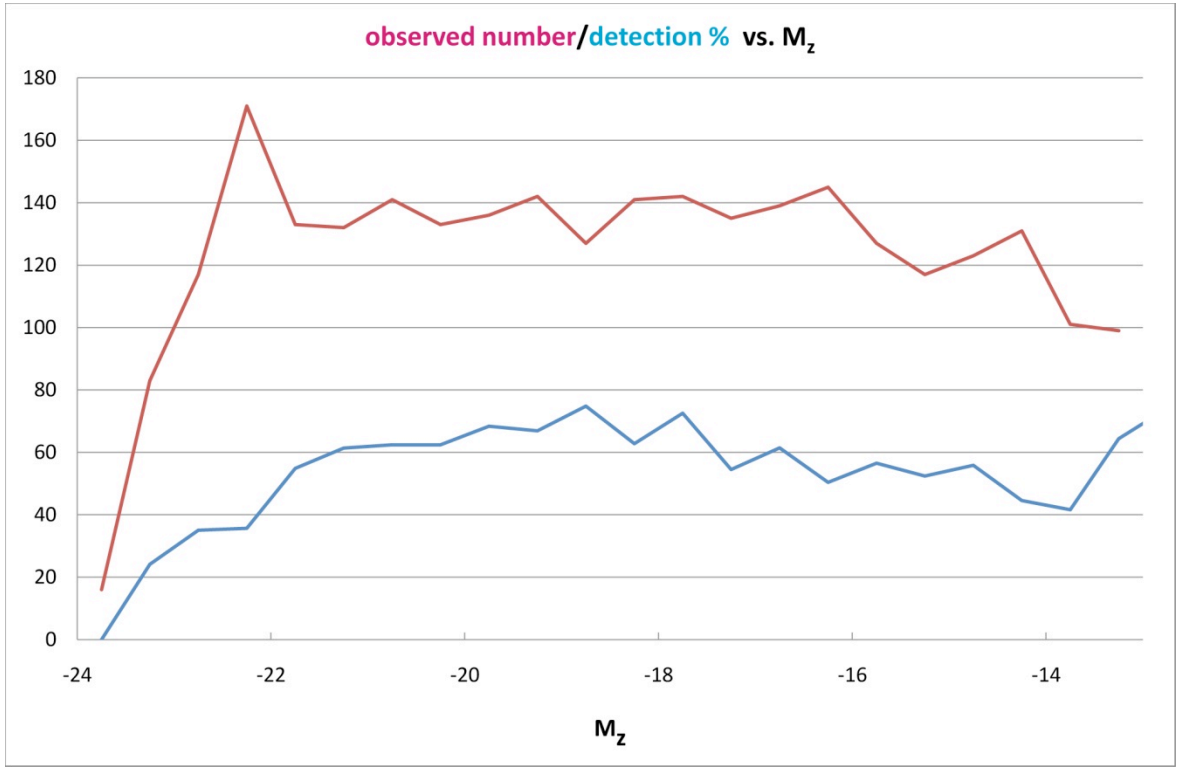
Their real luminosities are higher – and can be re-measured

Misunderestimated SDSS Petrosian magnitudes



Improbably high M_{HI}/L ratios found for lowest luminosity, tiny sources
Due to underestimated SDSS Petrosian magnitudes
- Started re-measuring with SourceExtractor , gives correct M_{HI}/L ratios

NIBLES: detection statistics



135 objects observed par 0.5 mag wide bin
Detection percentage rather constant : average 60%

NIBLES: detections as function of magnitude -1

M_z -21.75

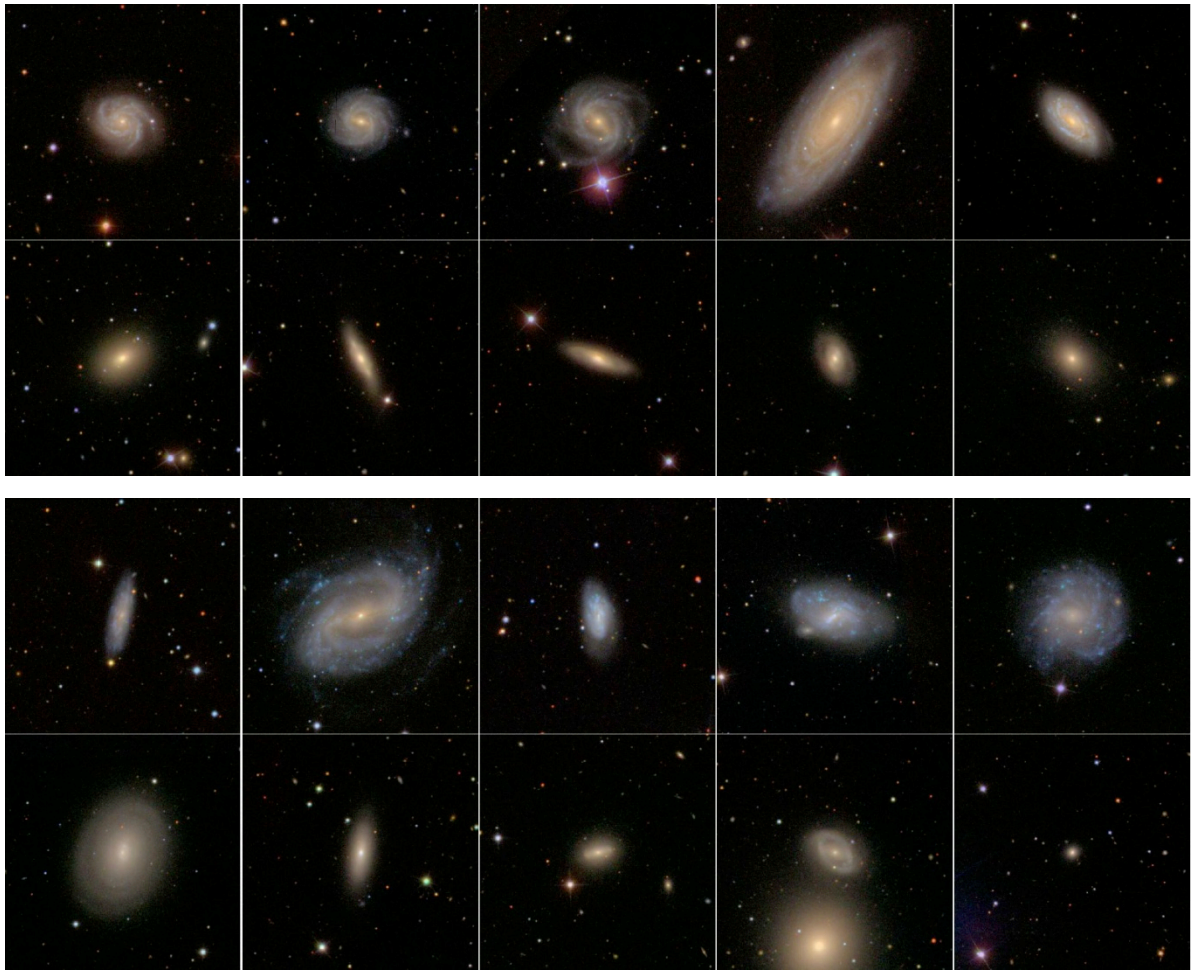
Detections

Non-dets

M_z -19.25

Detetections

Non-dets



M_z -21.75, -19.25: early-types not detected

NIBLES: detections as function of magnitude -2

M_z -16.75

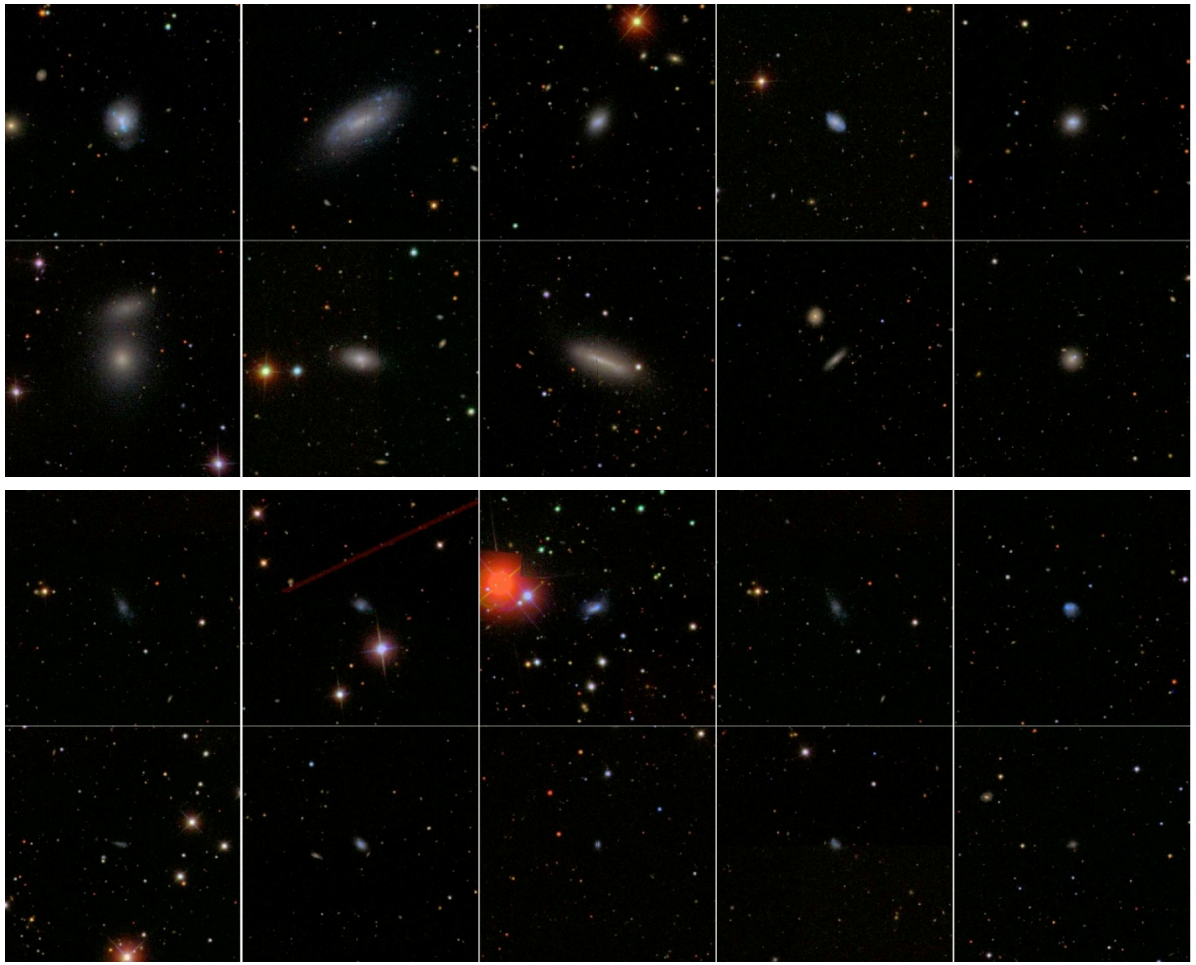
Detections

Non-dets

M_z -14.25

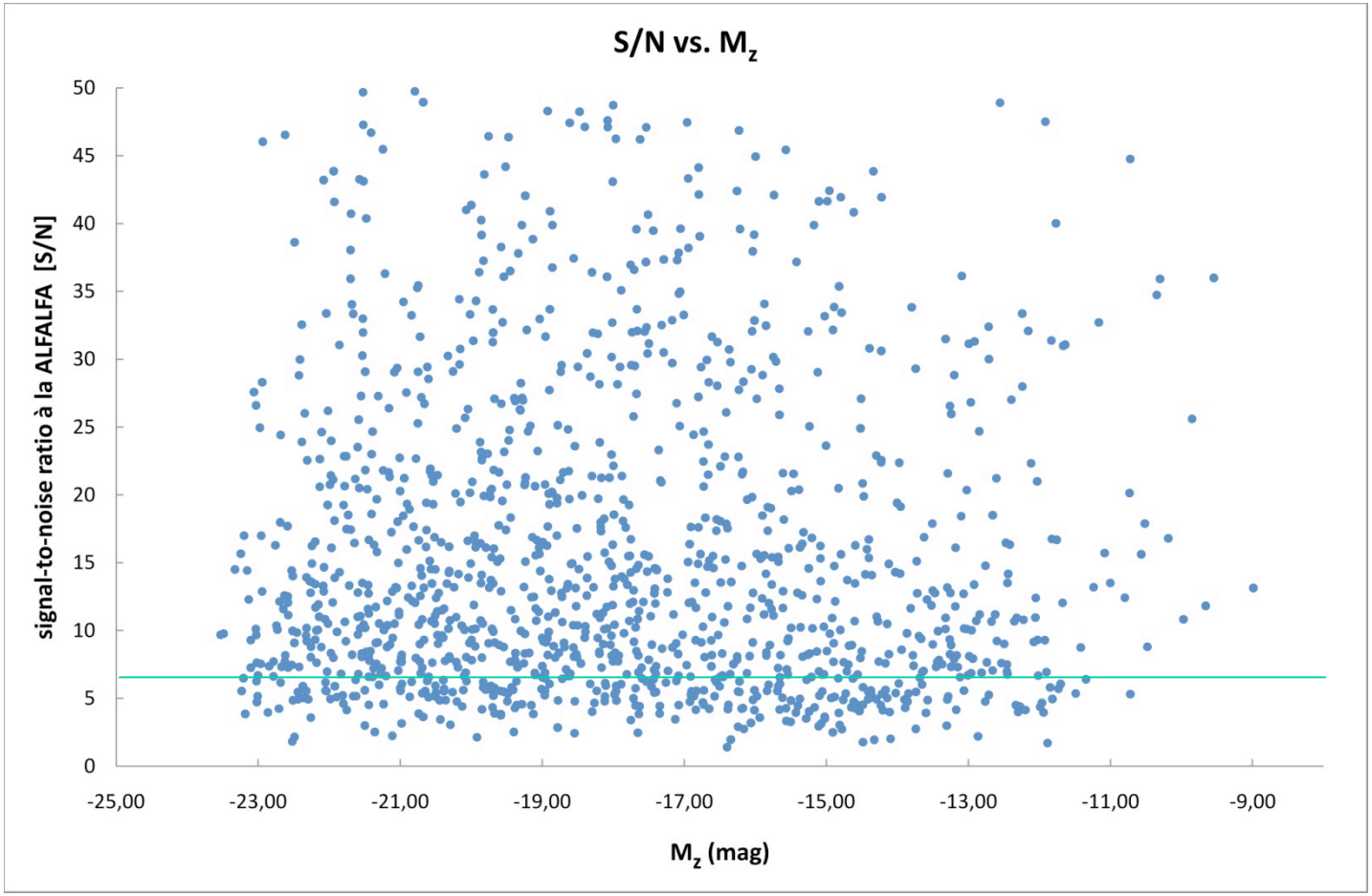
Detections

Non-dets



M_z -16.75: early-types not detected; M_z -14.25: ?

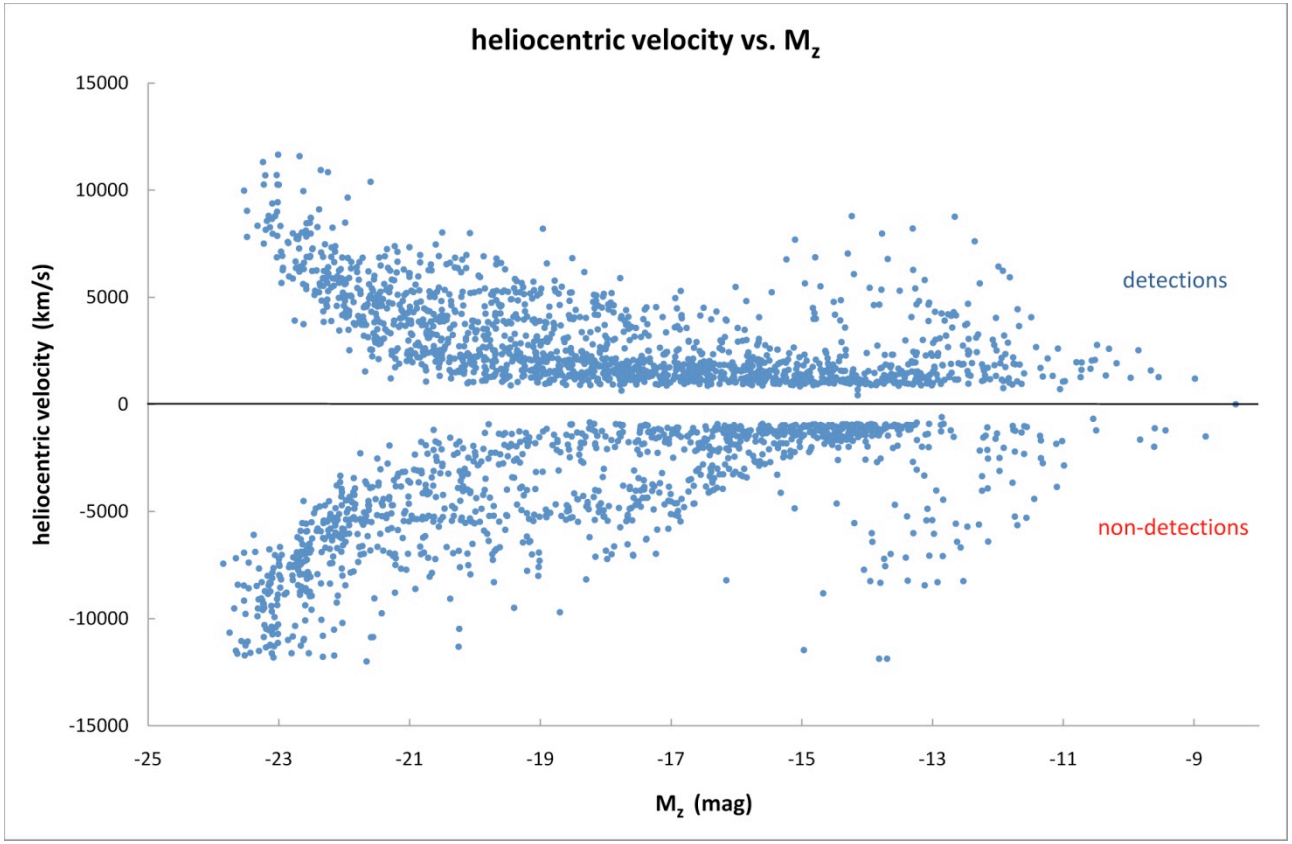
NIBLES: detectability



Results of short observations only

Reliability limit of blind HI surveys: S/N=6.5

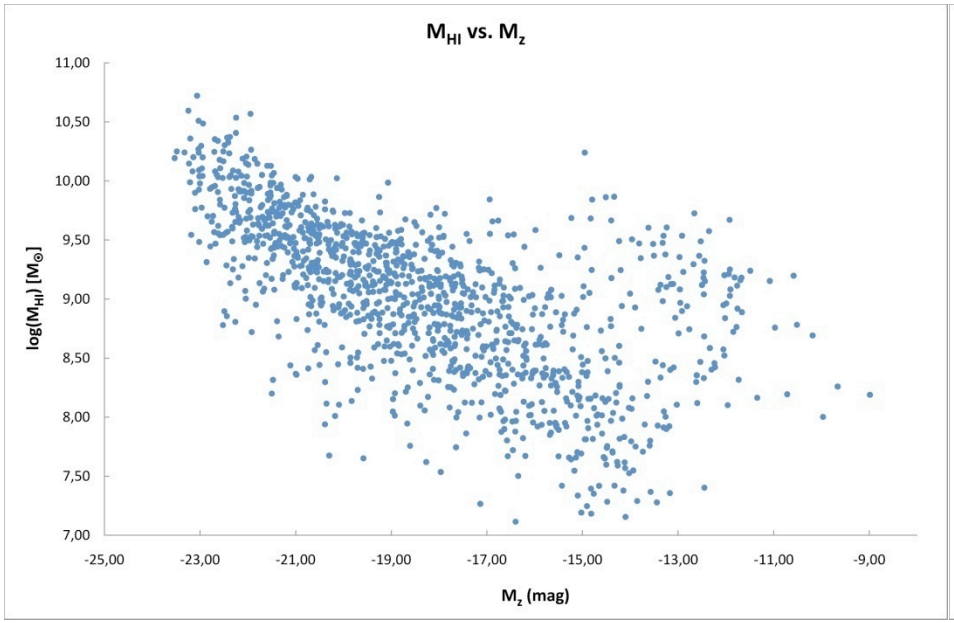
NIBLES: distances

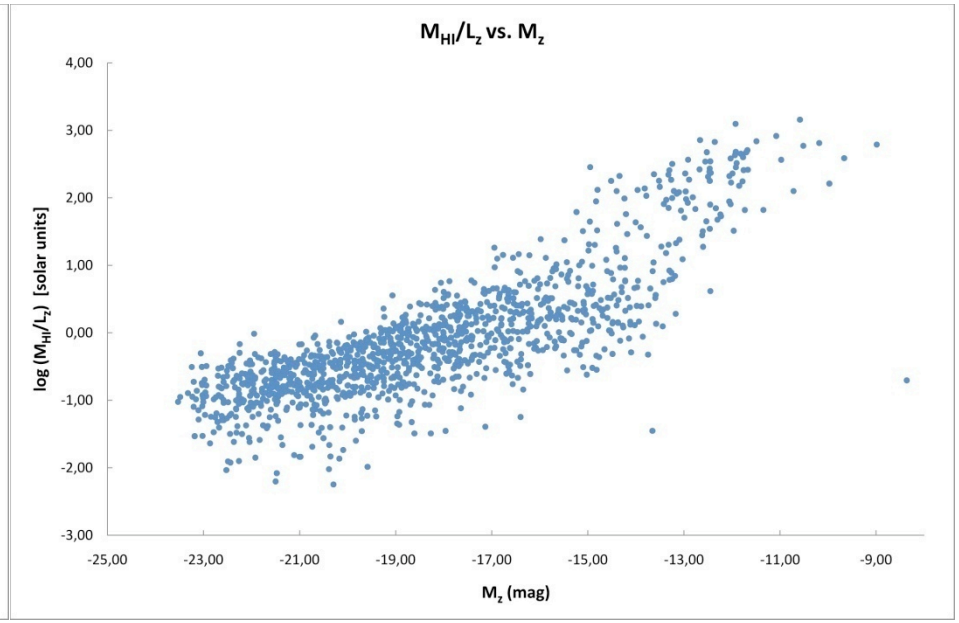


Started observing the most nearby objects

Detections and non-detections have similar velocity distributions

NIBLES: gas masses and gas content

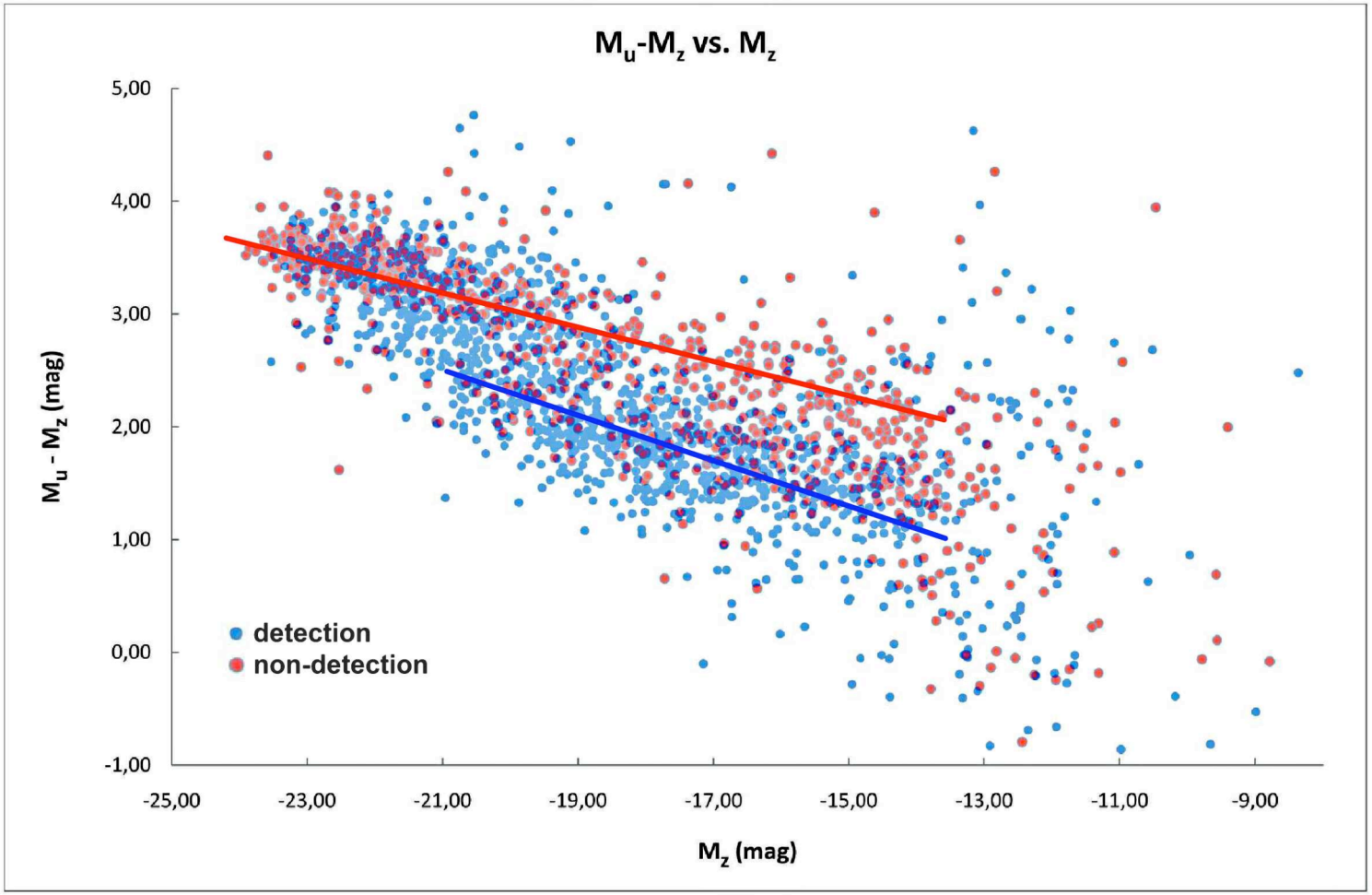




More luminous objects have higher M_{HI} but lower M_{HI}/L_z ratio

- confusion cases have not yet all been eliminated

NIBLES: detectability and colour



NIBLES: work in progress

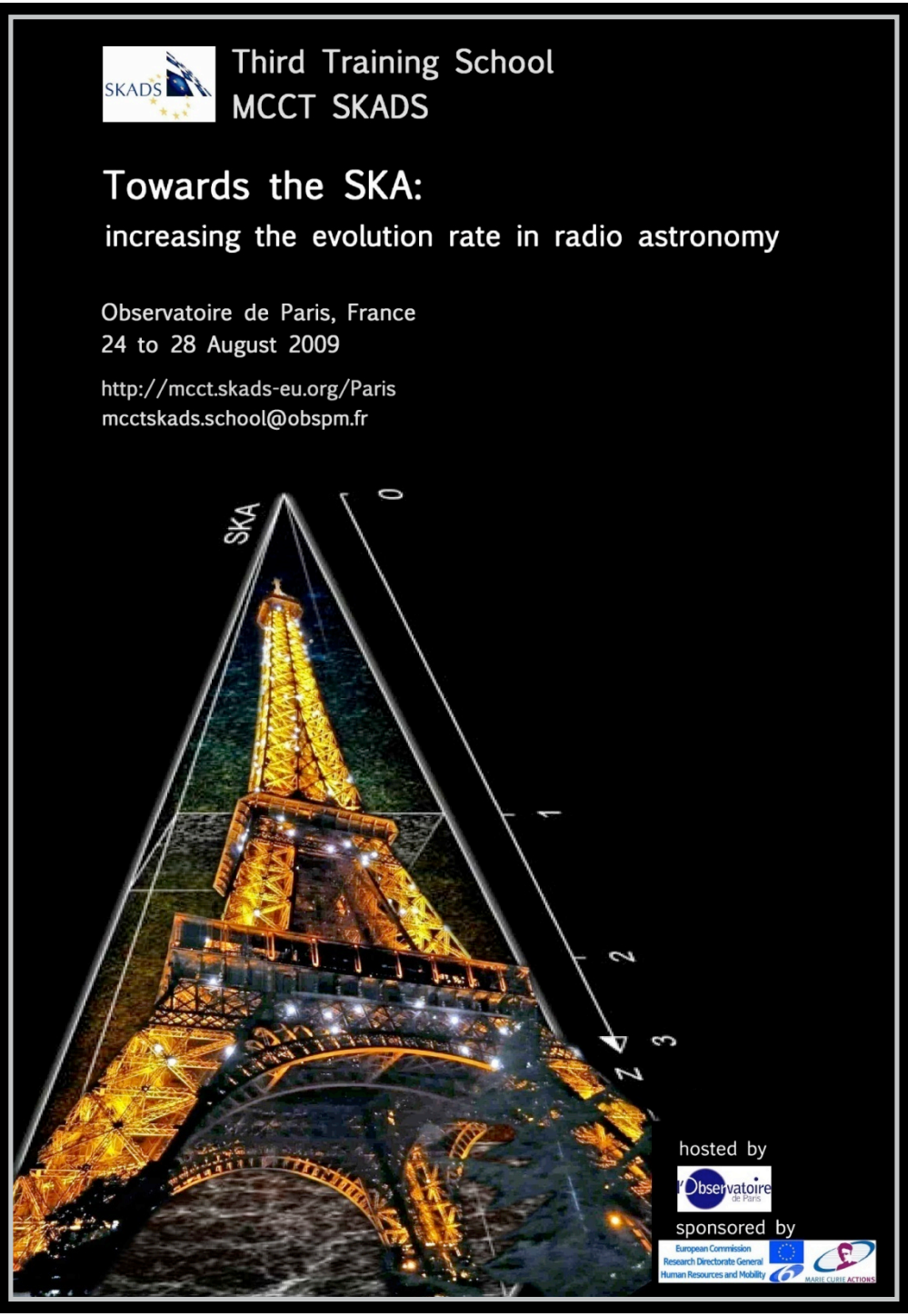
Hope to finish Nançay HI observations this year

Obtaining 5 times deeper Arecibo spectra

Stacking analysis of non-detections: CRUMBS (Sarah Blyth's talk)

Complementary CO observations (TICLES survey @ IRAM)

→ Insight in HI and related properties across absolute magnitude range



MCCT SKADS

Training School
Paris, August

MeqTrees Workshop
Nançay, September