HSC imaging of the Andromeda Halo Progress report

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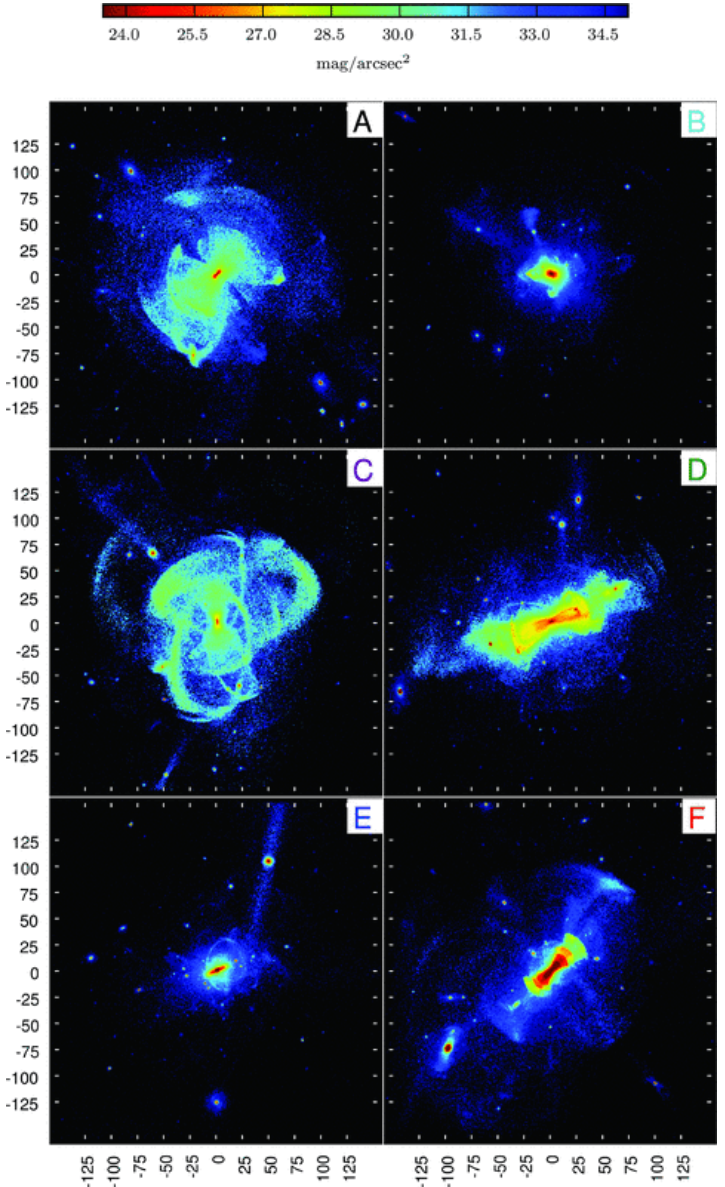
Motivation

Cooper+2010 Simulation
for formation of stellar halos



- Stellar halo component
  - Contains remnants of past merging events
  - Is a tracer of background dark halo
- Why the M31 halo?
  - External view of a halo from resolved stars
  - MW type galaxy

Clue to understanding disk galaxy formation

Issues on the M31 halo

Why observation with Subaru/HSC?

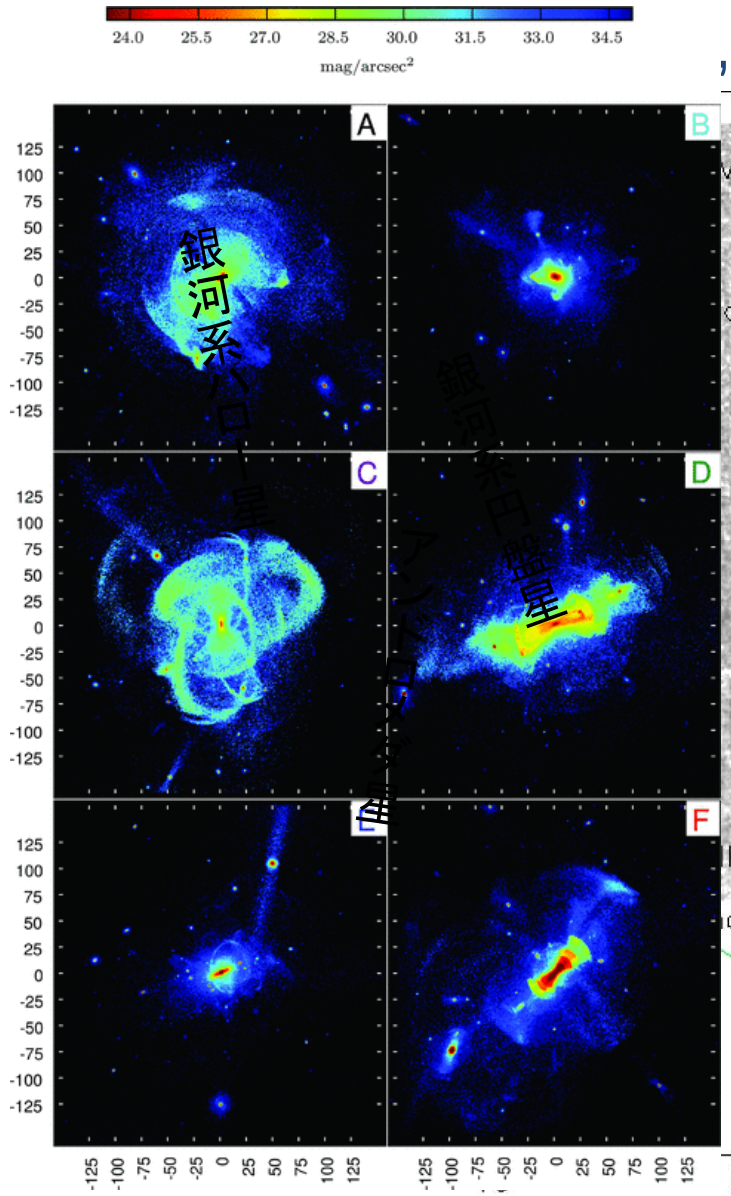
- Previously observed halo substructures are much less significant than theoretical prediction
  - These are based on only bright RGB stars
- Metallicity and age distributions of halo substructures are yet unclear
  - These are degenerated for RGBs
- Many faint satellites are undetected
  - These contain only a small number of RGBs

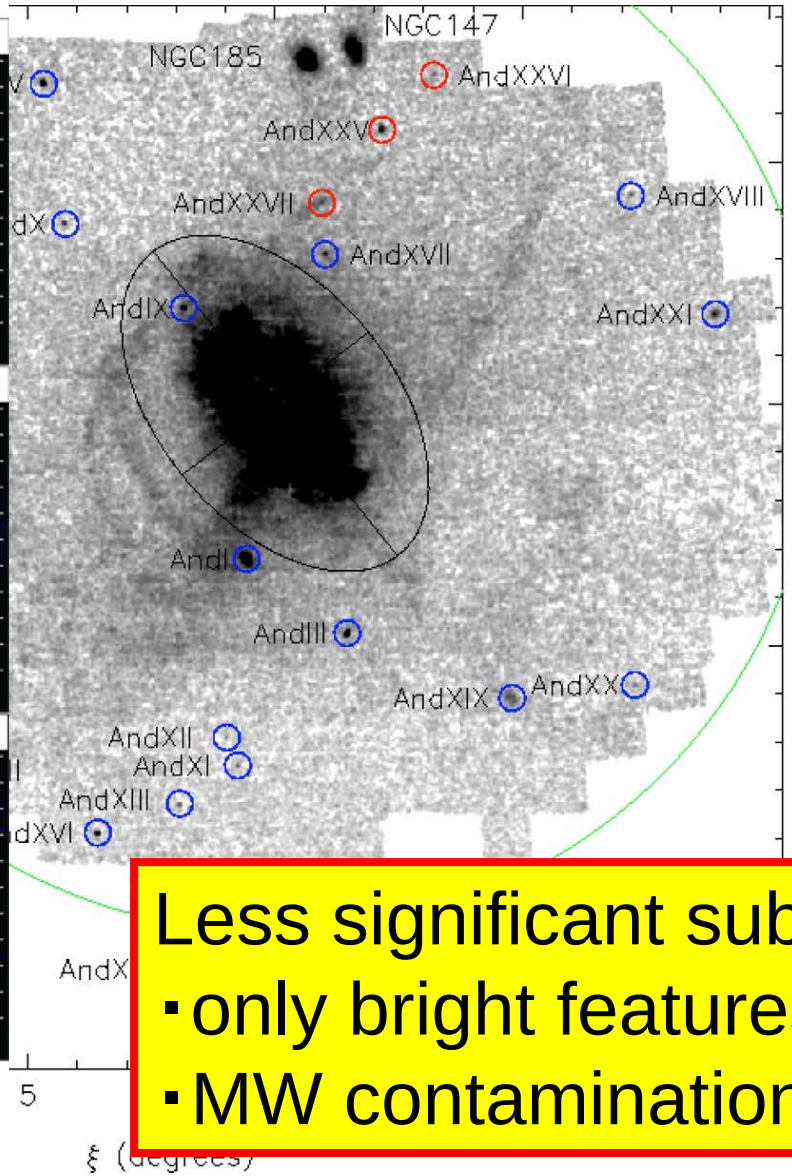
With only bright RGBs, true halo structures are yet uncertain.

Cooper+2010
Simulated halos

PAndAS Survey

, mapping with bright RGBs





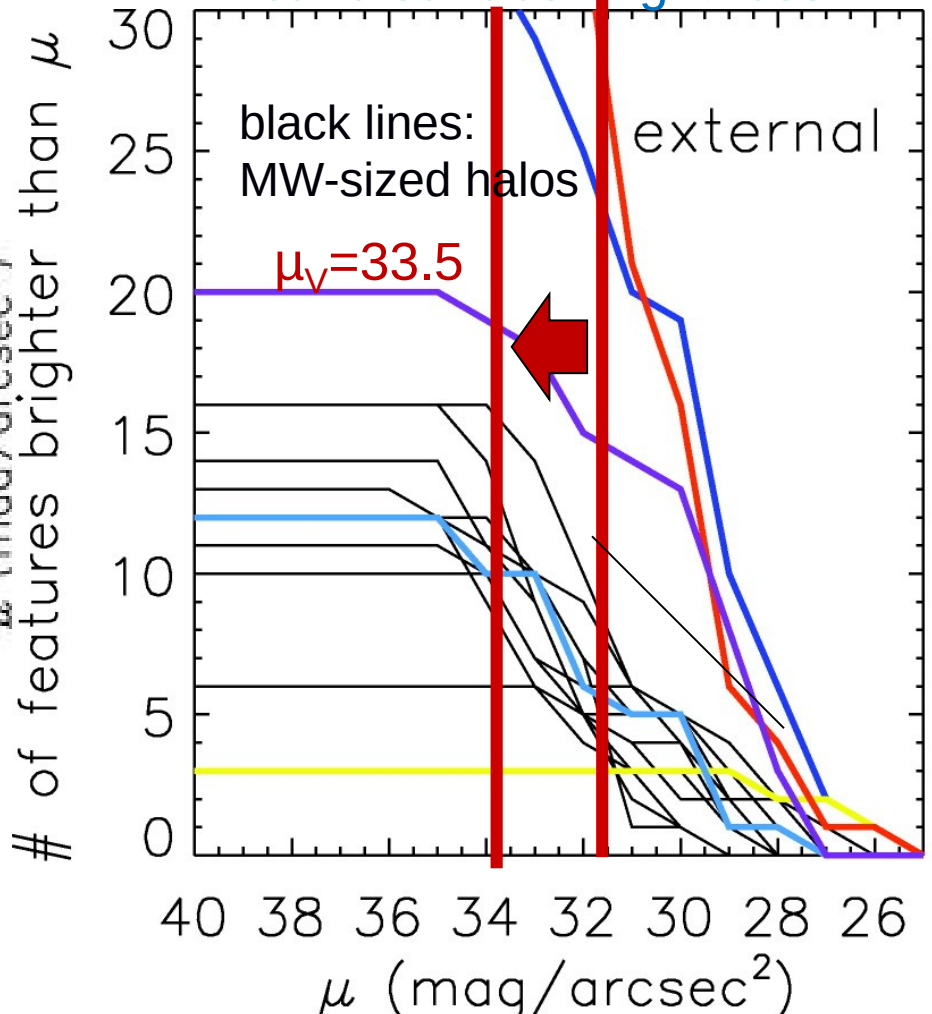
(Richardson+11)

RGB
with
i<23.5

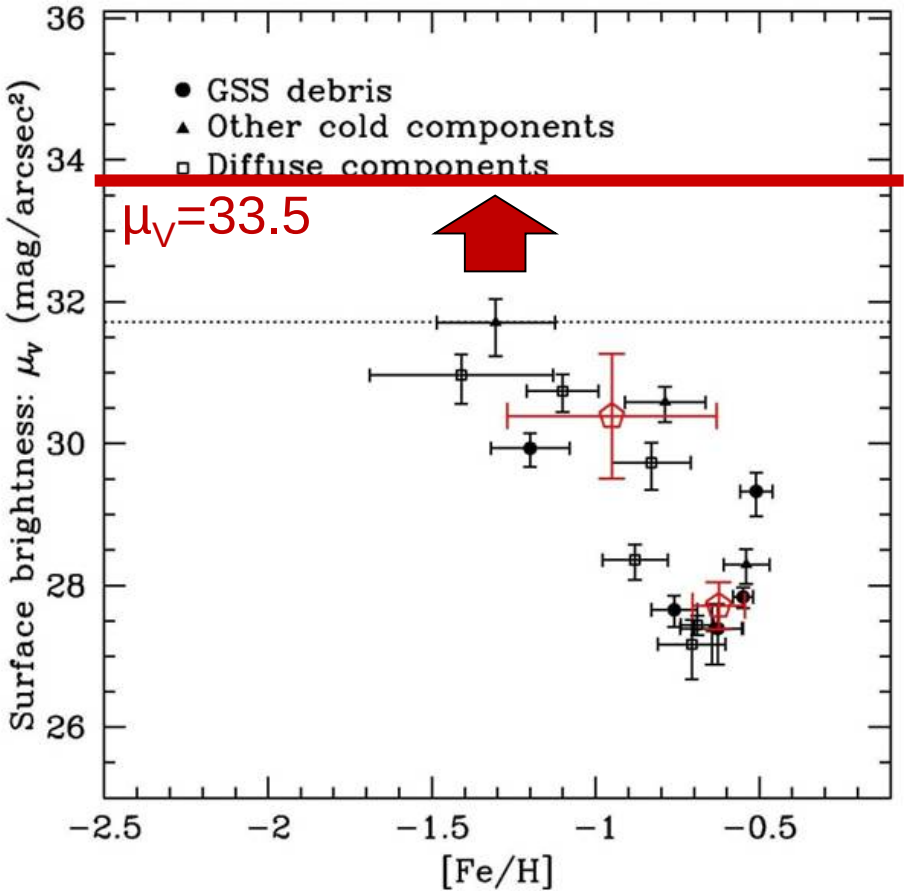
Less significant substructures
- only bright features
- MW contamination

Substructures: theoretical prediction

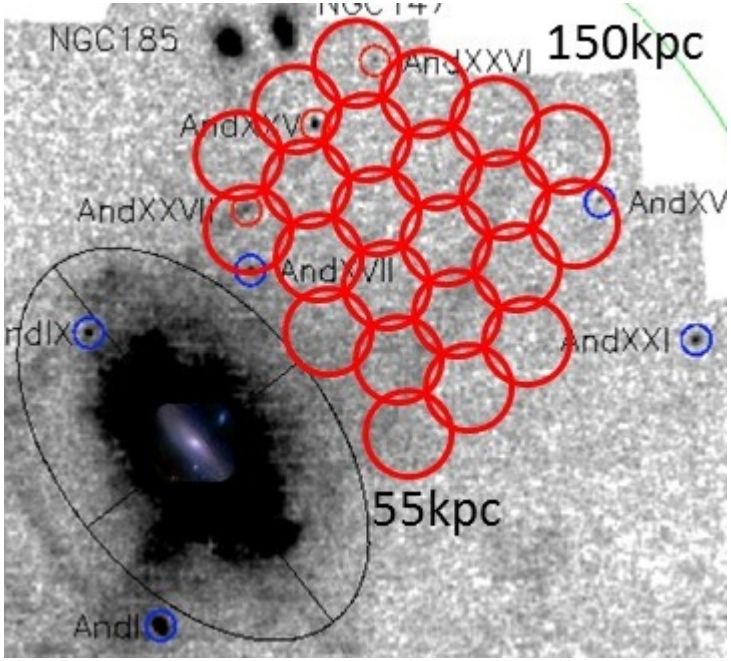
ΛCDM simulation(Johnston+2008)
11 MW-sized halos
V-band surface brightness



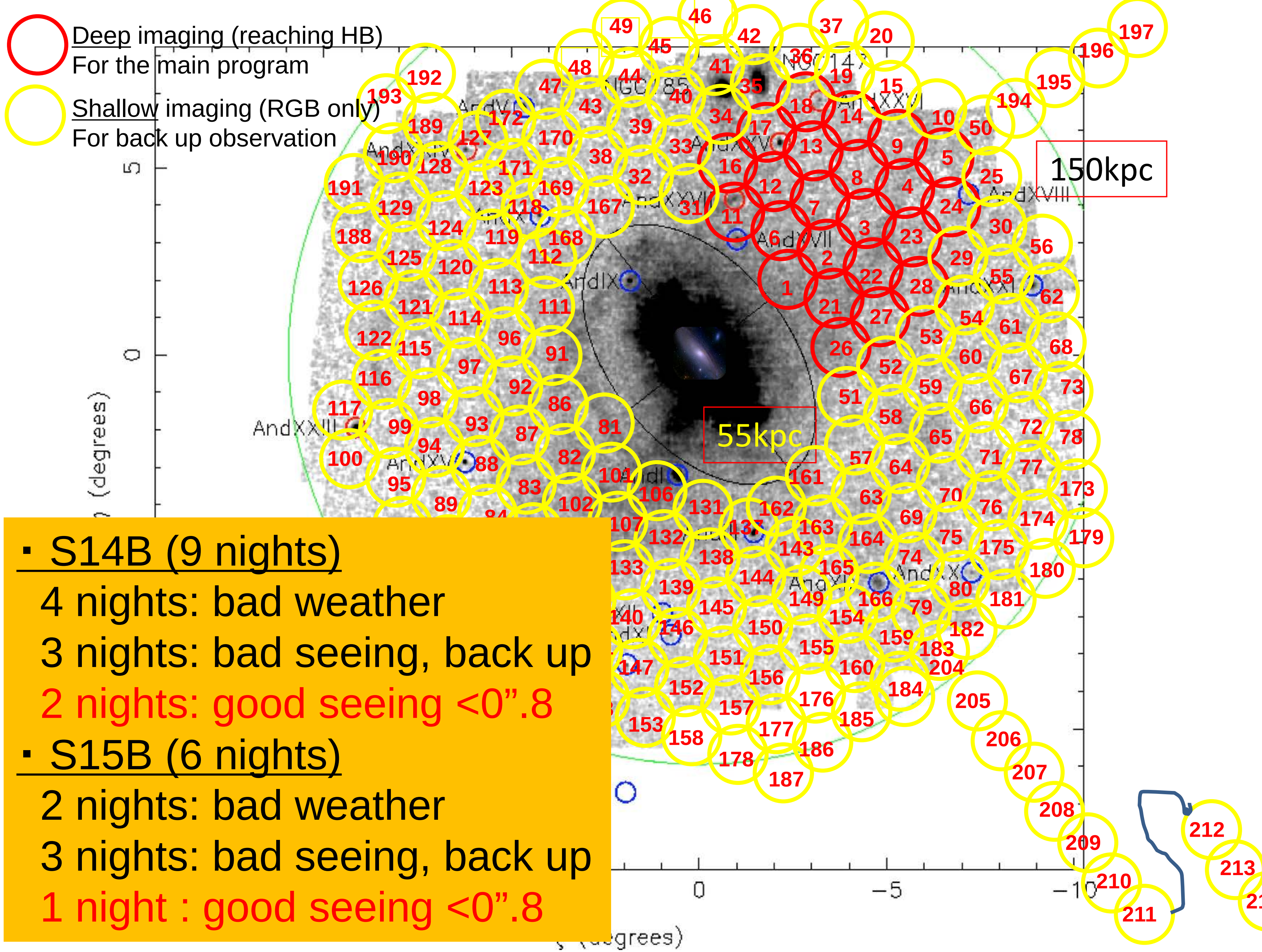
M31 observation(Gilbert+2009)



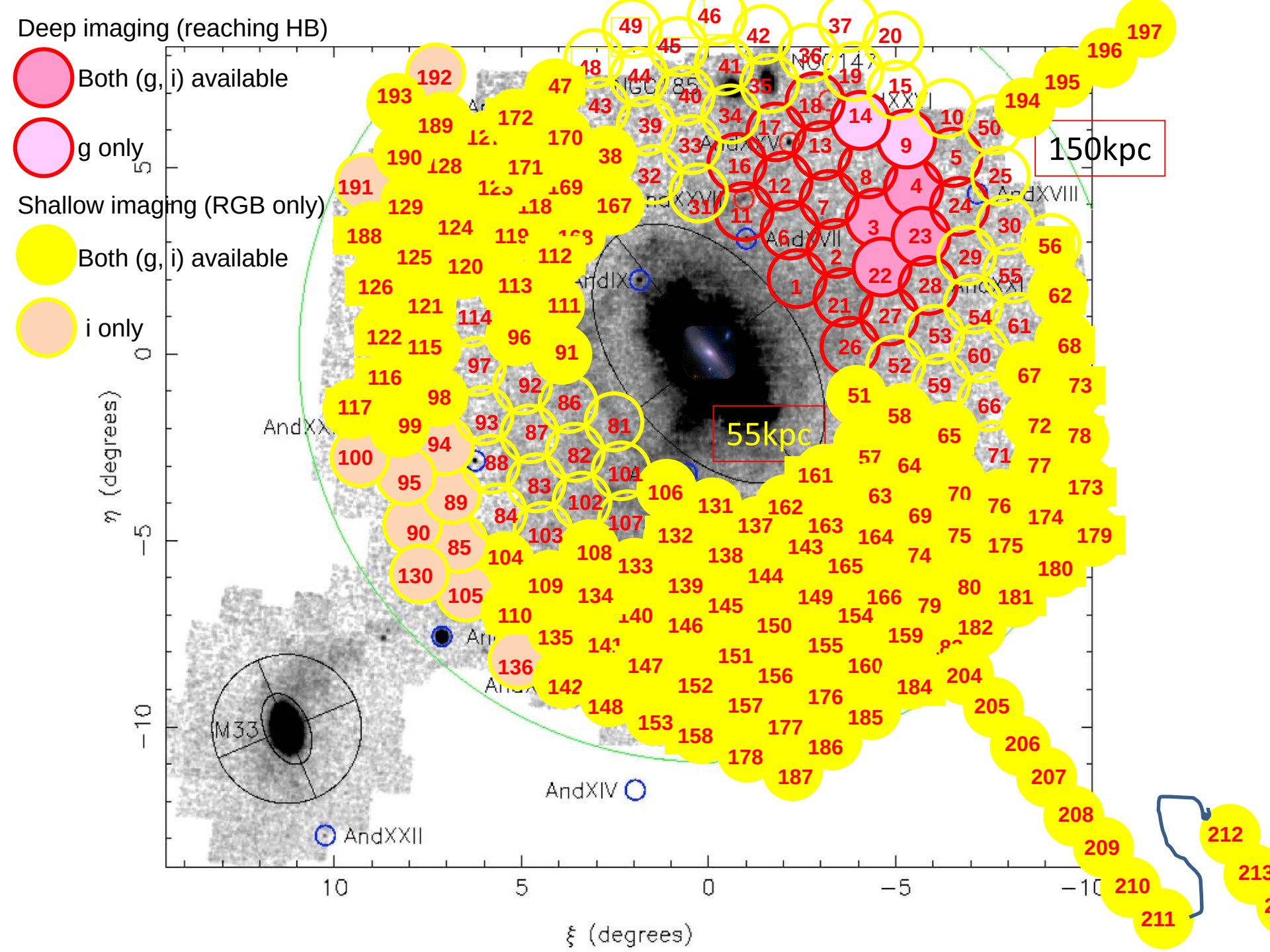
This deep+wide survey program

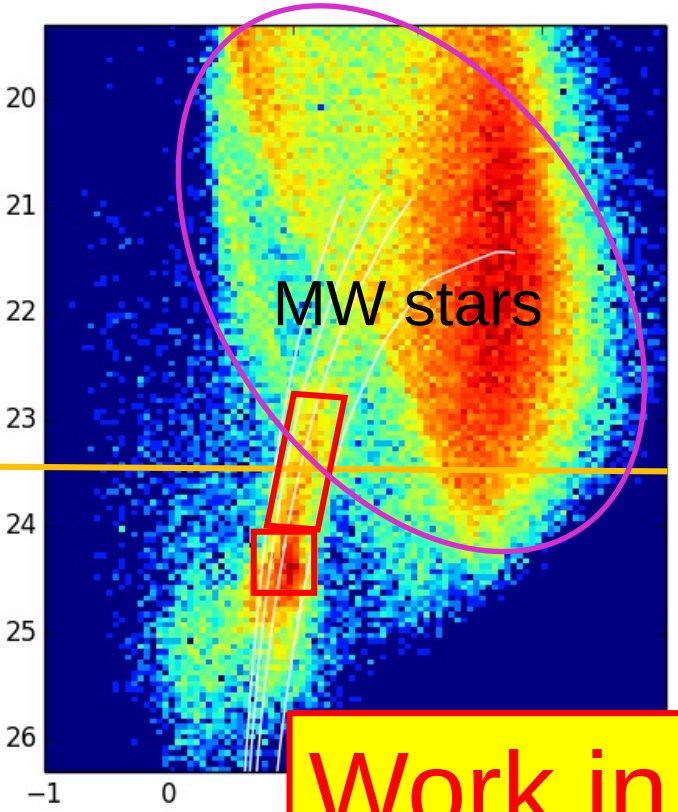


- Outer halo regions in M31
  - ~6 x 6 deg^2 (23 pointings)
- Deep to reach HB stars
  - g < 27.4, i < 26.4
- Selection of probable RGBs
  - NB515 < 25.5 (for g<23)
  - To break the metal-age degeneracy by combining the HB and RGB stars
- Detection of new substructures and satellites
  - Group finding method



- **S14B (9 nights)**
  - 4 nights: bad weather
  - 3 nights: bad seeing, back up
  - 2 nights: good seeing <0".8
- **S15B (6 nights)**
  - 2 nights: bad weather
  - 3 nights: bad seeing, back up
  - 1 night : good seeing <0".8

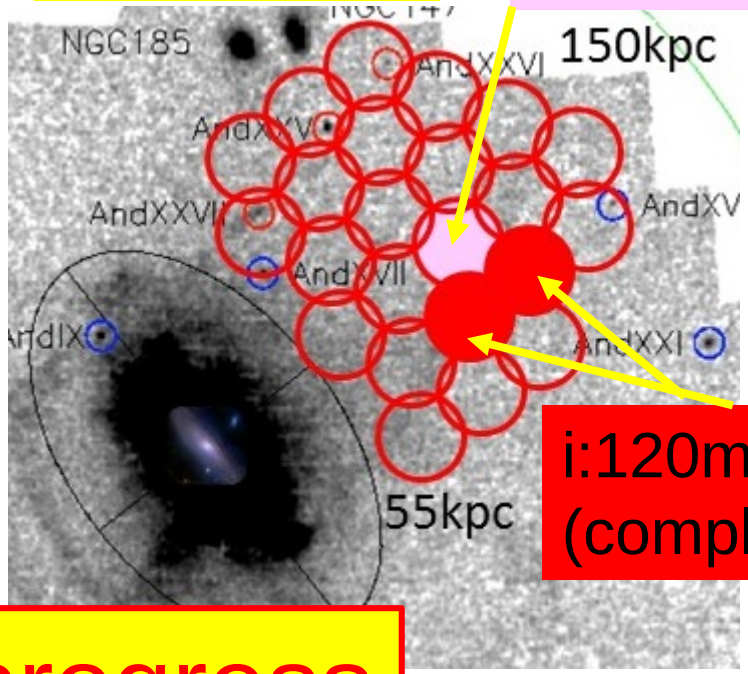

Deep imaging (reaching HB)
Both (g, i) available
g only
Shallow imaging (RGB only)
Both (g, i) available
i only
150kpc
55kpc
M33
AndXIV
AndXXII
η (degrees)
ξ (degrees)
10
5
0
−5
−10



PAndAS

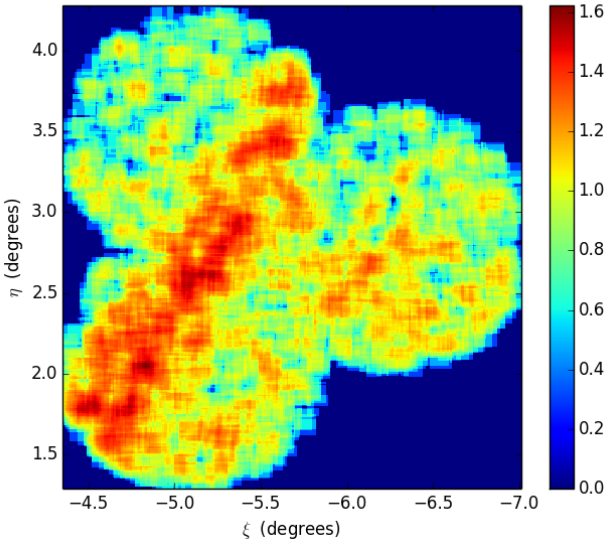
S14B results

i:100min

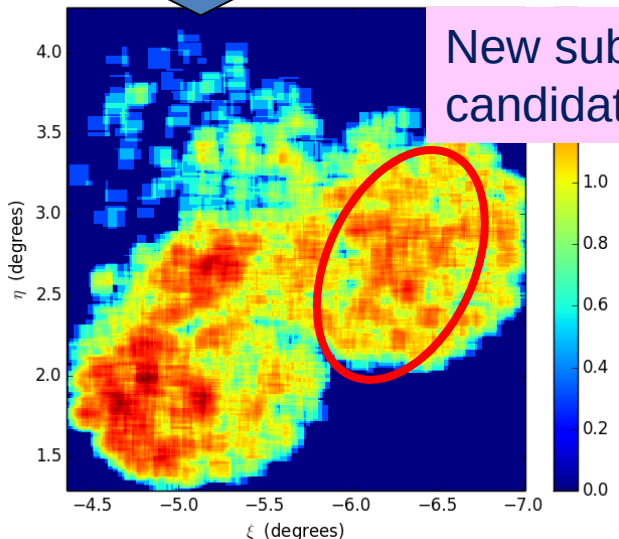


i:120min
(completed)

Work in progress



RGBs
(22.7<
i<24.0)



New substructure
candidate

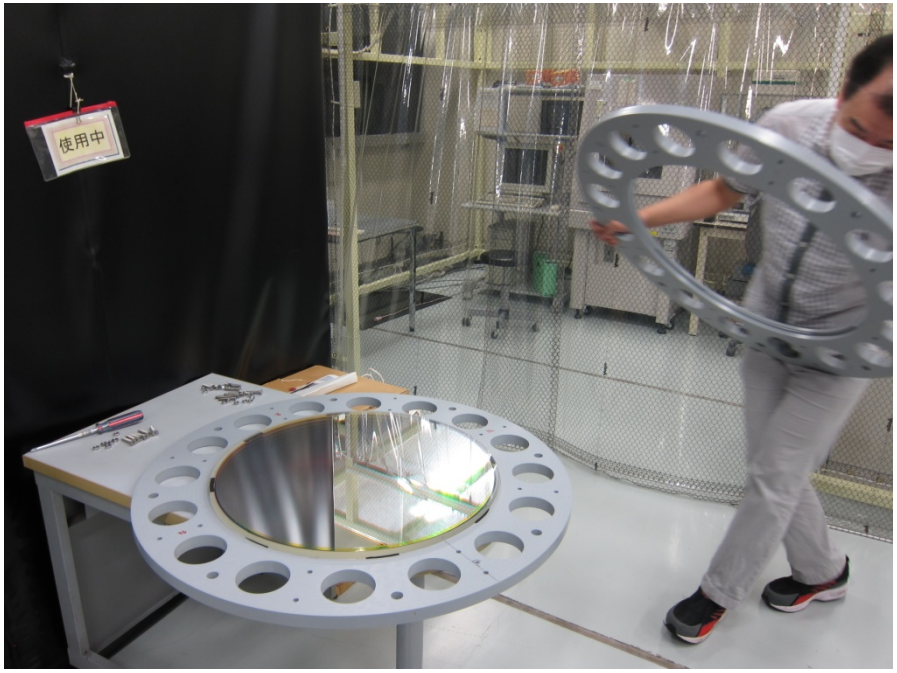
Red
Clumps
(24.1<
i<24.7)

NB515 filter for HSC (from S15A)

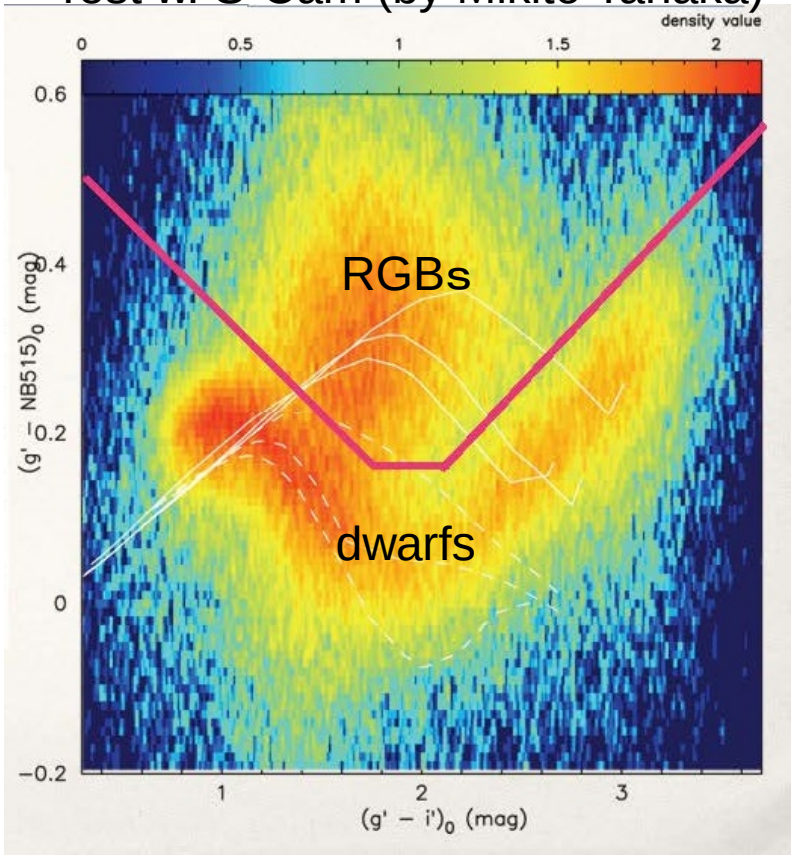
CW: 515 nm, FWHM: 8nm

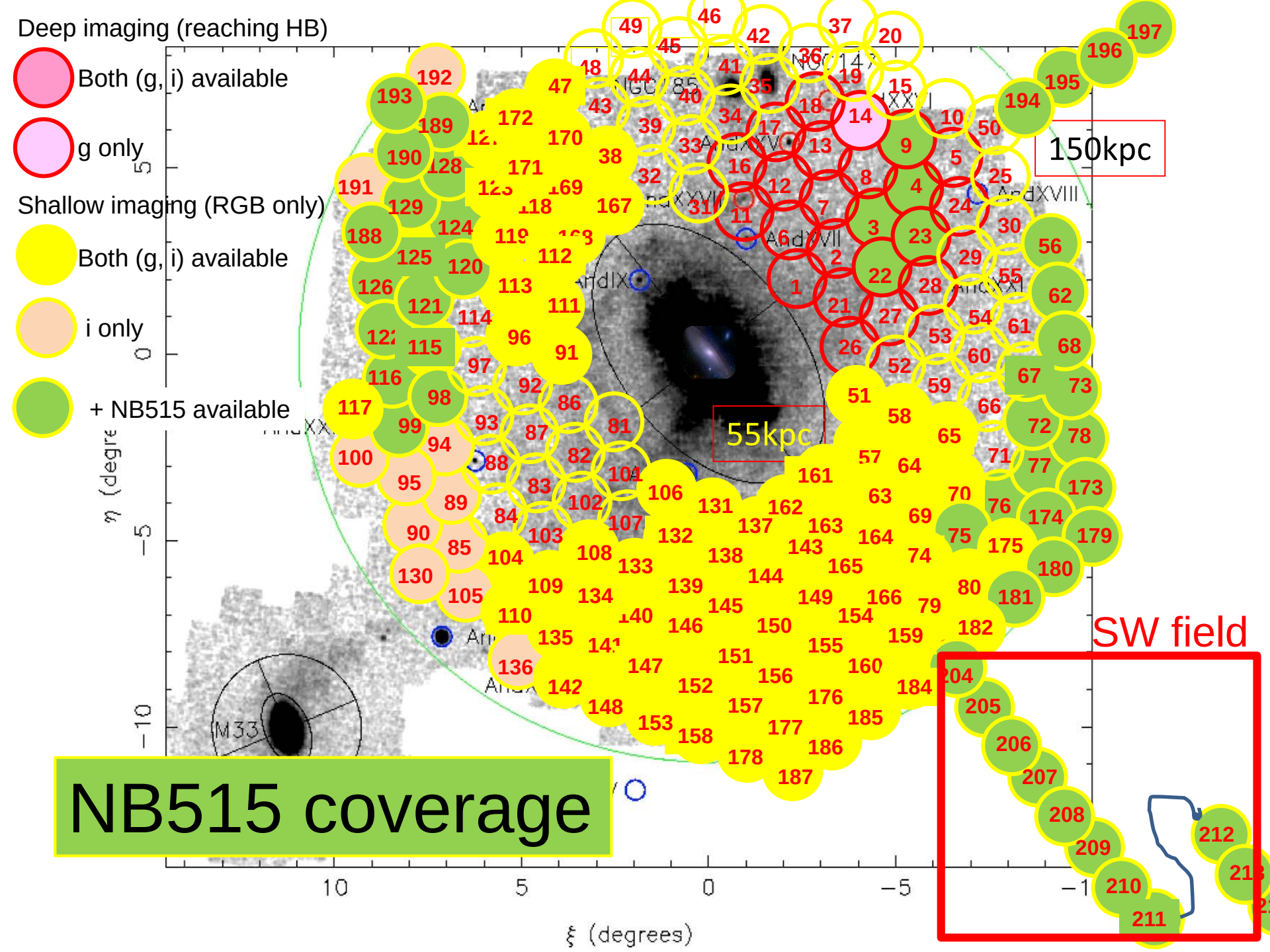
Separation of RGB stars in M31 halo + MW satellites from the foreground MW dwarfs

Aug 28, 2013



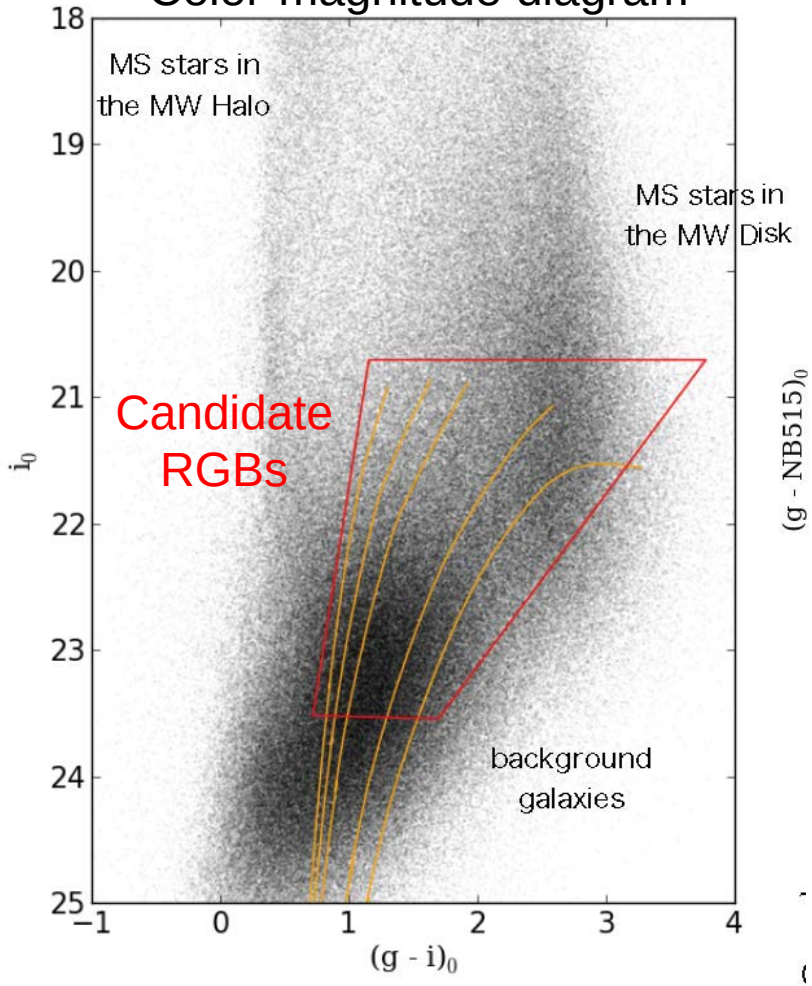
Test w. S-Cam (by Mikito Tanaka)



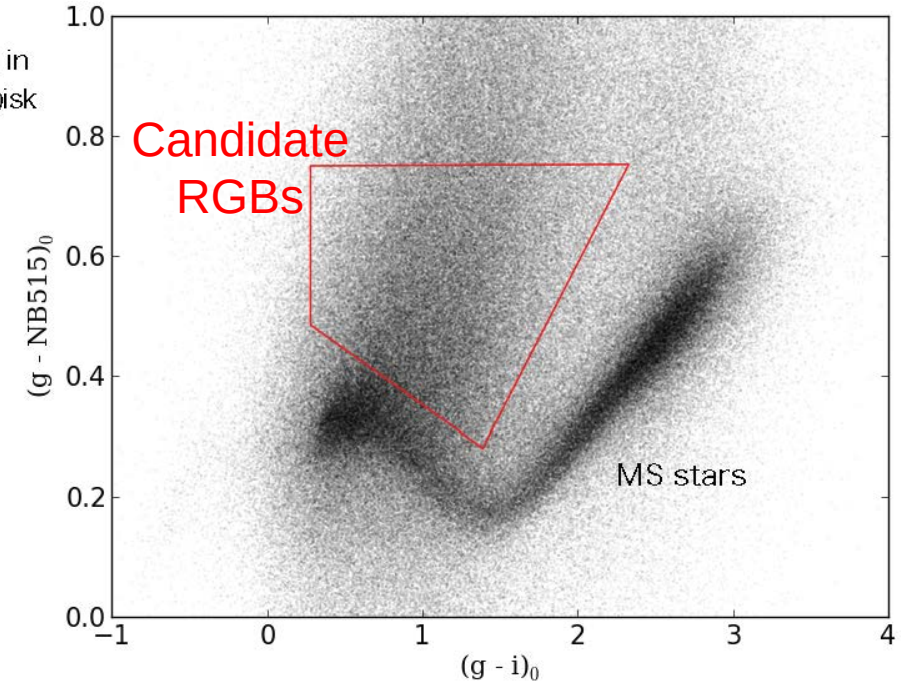

Deep imaging (reaching HB)
Both (g, i) available
g only
Shallow imaging (RGB only)
Both (g, i) available
i only
+ NB515 available
150kpc
55kpc
SW field
NB515 coverage
M33
η (degrees)
ξ (degrees)

Analysis of RGBs along the major axis with the use of NB515 (Tanaka+)

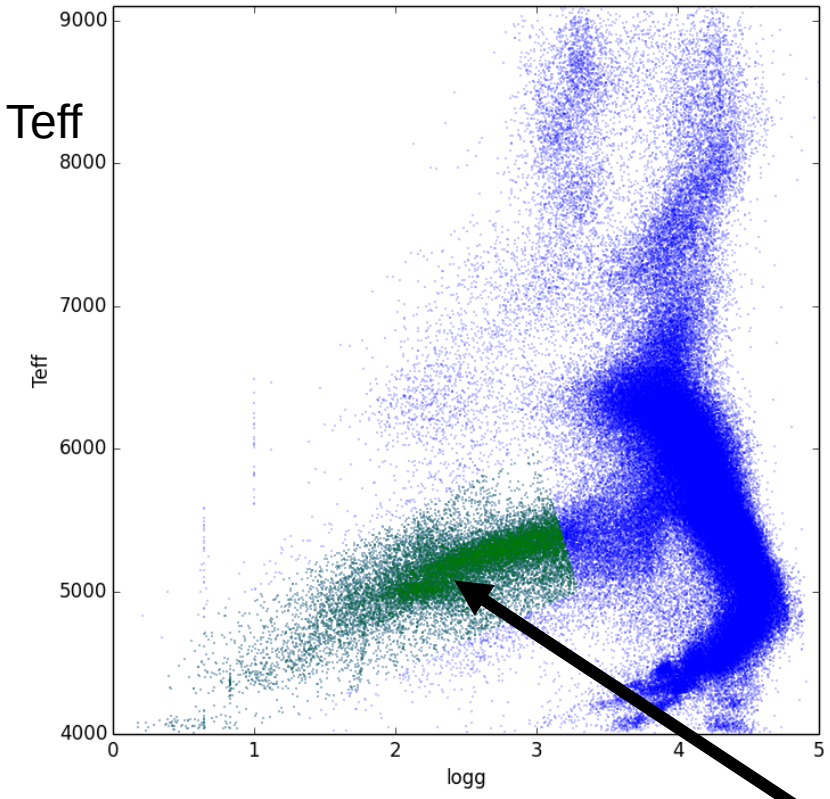
Color-magnitude diagram



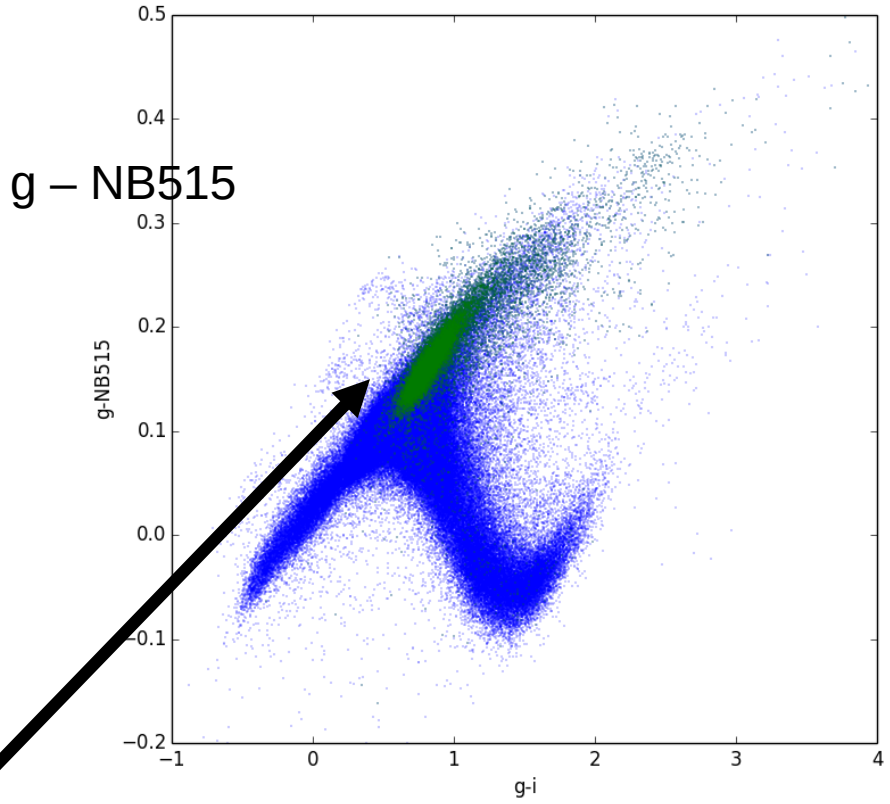
Two-color diagram



The case of spectroscopically confirmed RGBs from SEGUE



log g

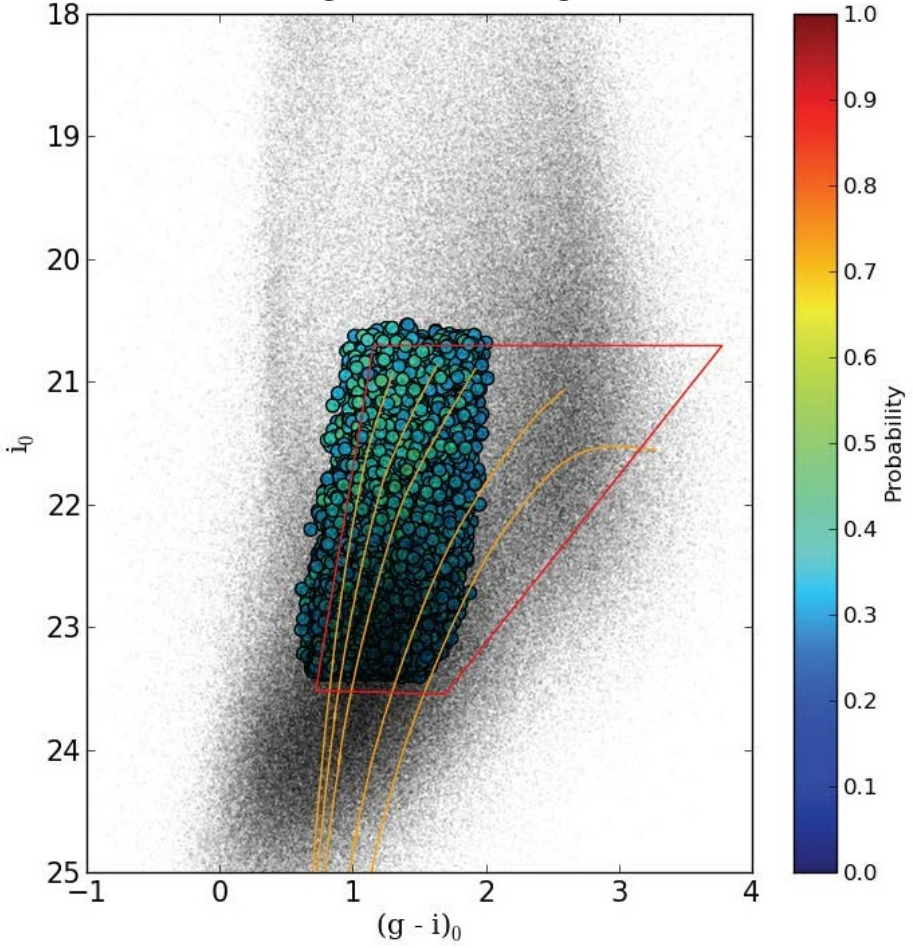


g - i

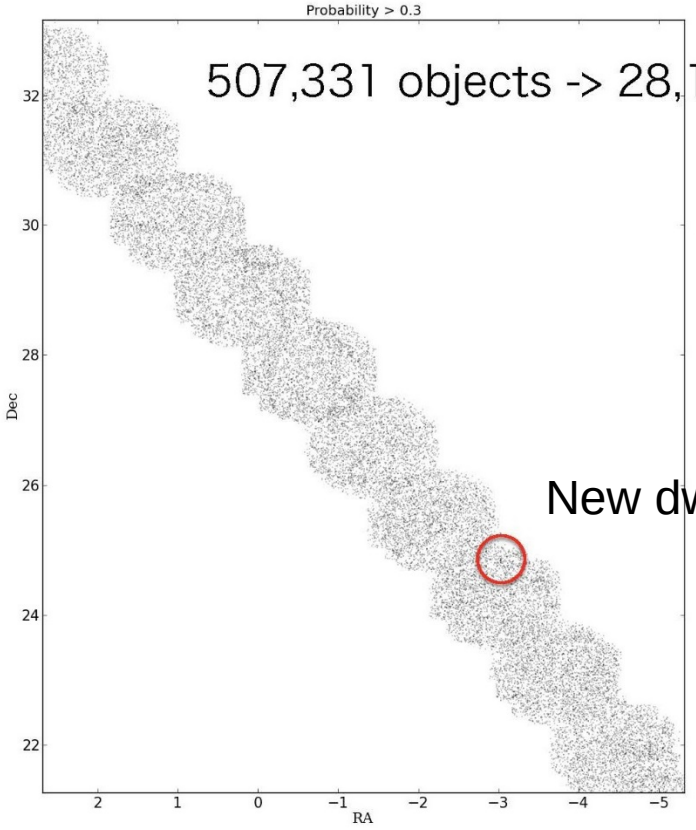
RGBs

Stars with high probability (P>0.3) as RGBs in M31

Color-magnitude diagram



Spatial distribution



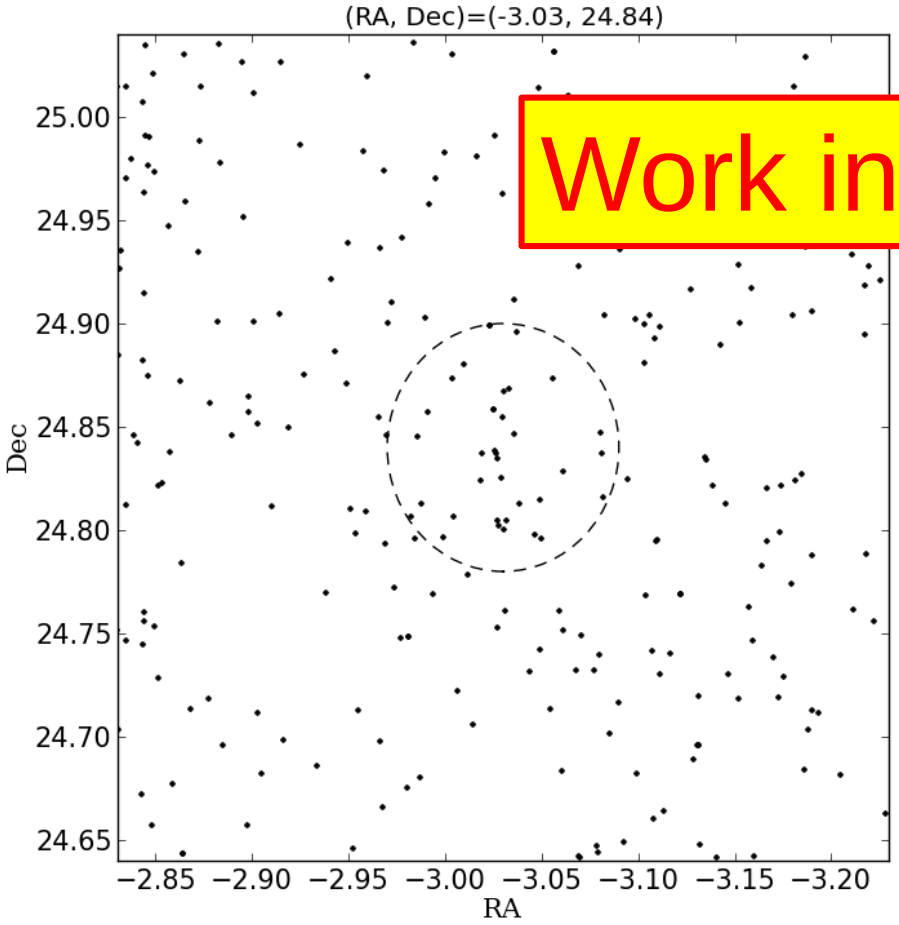
507,331 objects -> 28,124 objects

~ 5.5%

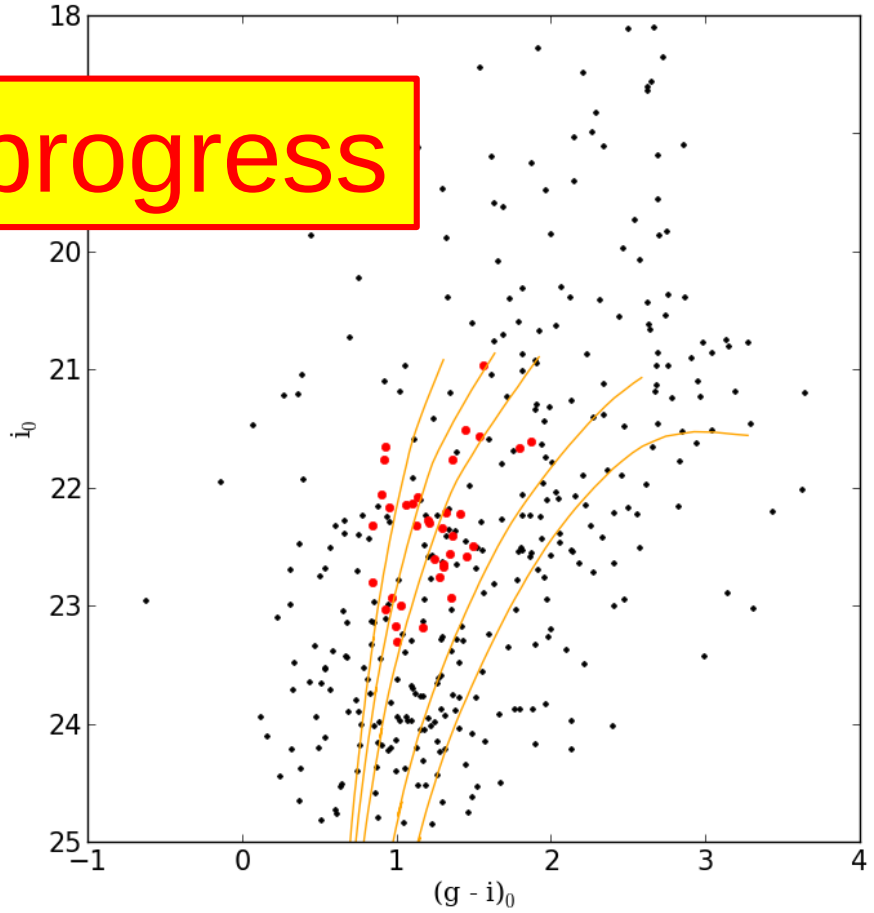
New dwarf?

The selection method for PFS targets is established.

New dwarf?



Work in progress



Spatial distribution of RGB candidates with P > 0.3

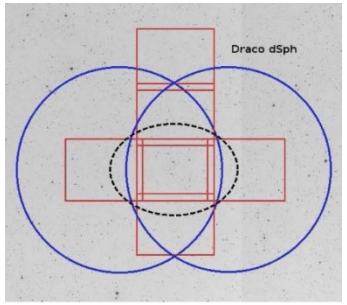
CMD for stars inside a dashed circle with P > 0.3 (red points)

HSC imaging campaign of MW dSphs with Subaru + Keck/Subaru time (Cohen+)

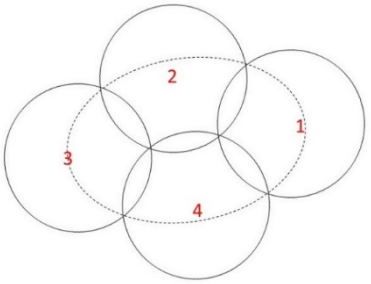
Name	Short exposure (RGBs)			Long exposure (~ MSTO)			Note
	g	i	NB515	g	i	NB515	
Draco (2 fields)	F1, F2	F1, F2	F1, F2	F1, F2	F1, F2	F1, F2	
Sculptor (4 fields)	**F1, F2, F3, F4**	**F1, F2, F3, F4**	F1, F2, F3, F4	**F1, F2, F3,** F4	F1, F2, F3, F4	F1, F2, F3, F4	S15B
Fornax (4 fields)	F1, **F2, F3,** F4	F1, **F2, F3,** F4	F1, F2, F3, F4	F1, F2, F3, F4	F1, **F2, F3,** F4	F1, F2, F3, F4	S15B
Ursa Minor (4 fields)	F1, F2, F3, F4	F1, F2, F3, F4	F1, F2, F3, F4	F1, F2, F3, F4	F1, F2, F3, F4	F1, F2, F3, F4	S15A
Leo I							
Sextans (19 fields)	F1 – F19	F4, 5, 6, 12,13, 14,18	F1 – F19	Not required			Short exposures for (g, i) were made during M31 halo run in 2014 Nov

Field number
Red: done
(Bold red: done in S15B)
Black: not yet

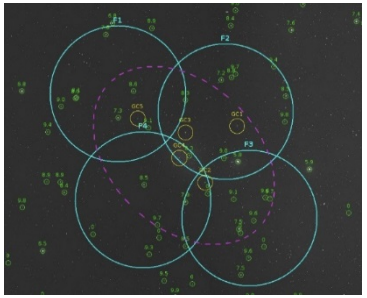
Draco



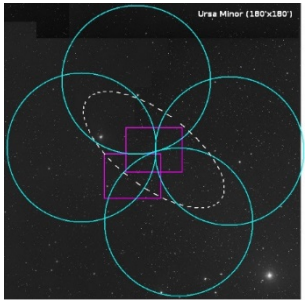
Sculptor



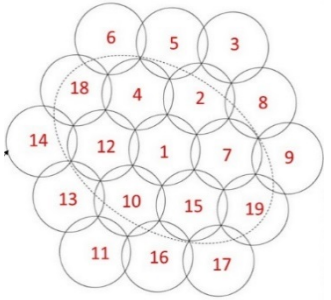
Fornax



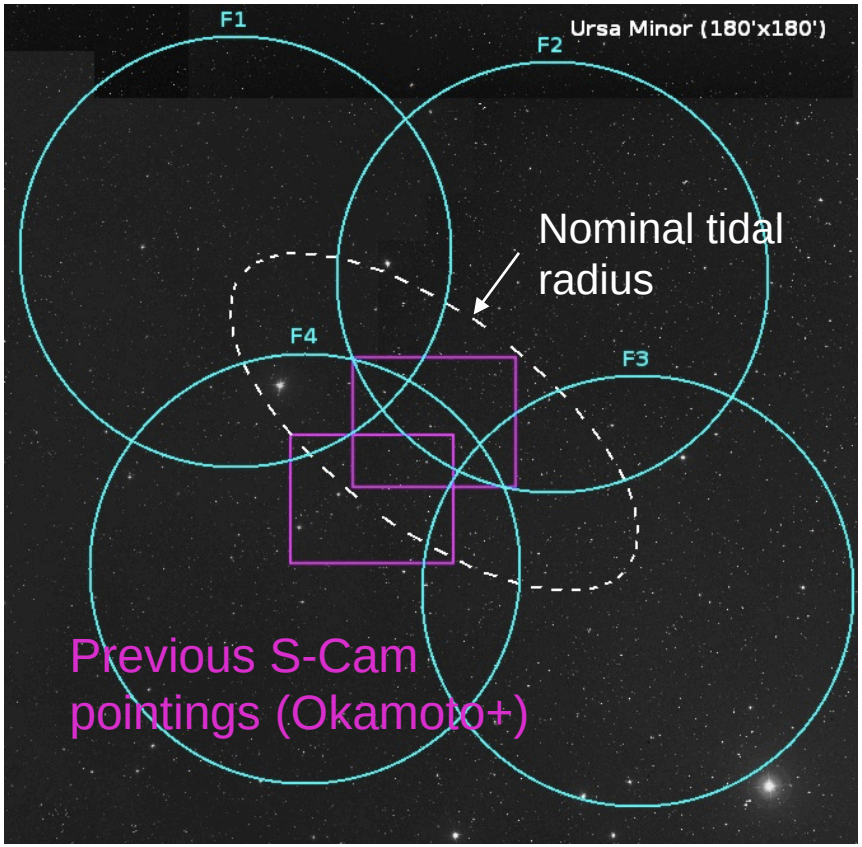
Ursa Minor

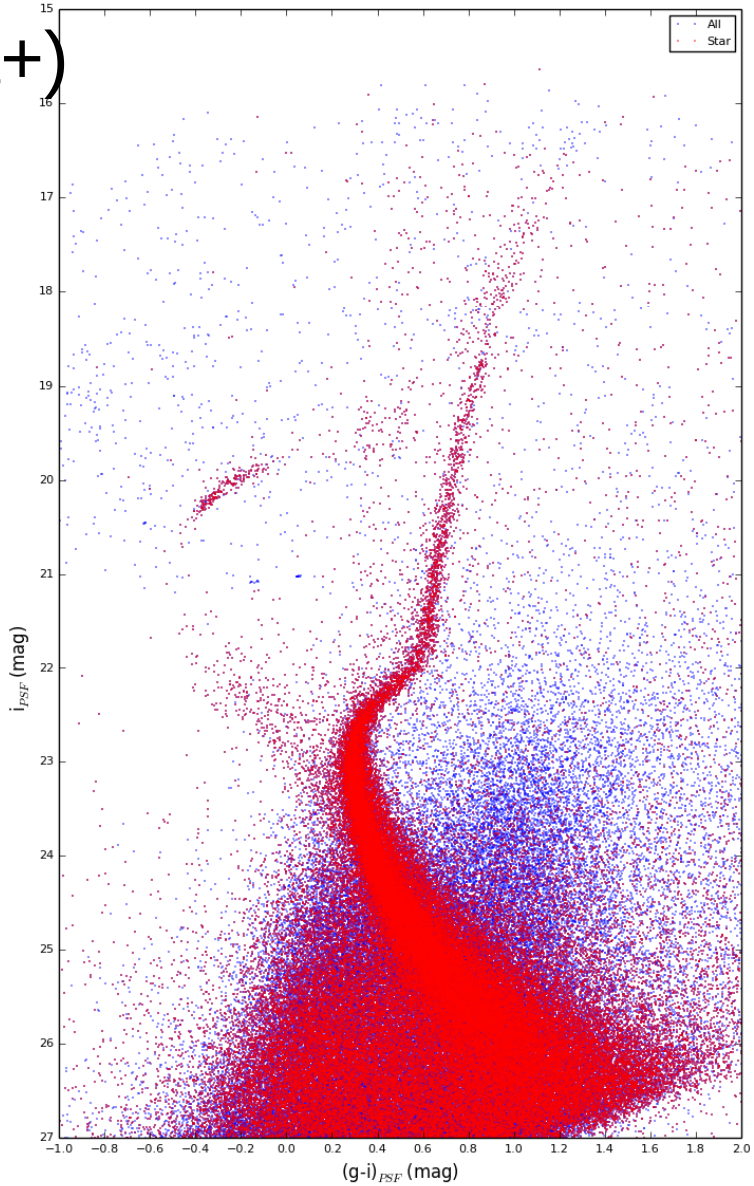


Sextans

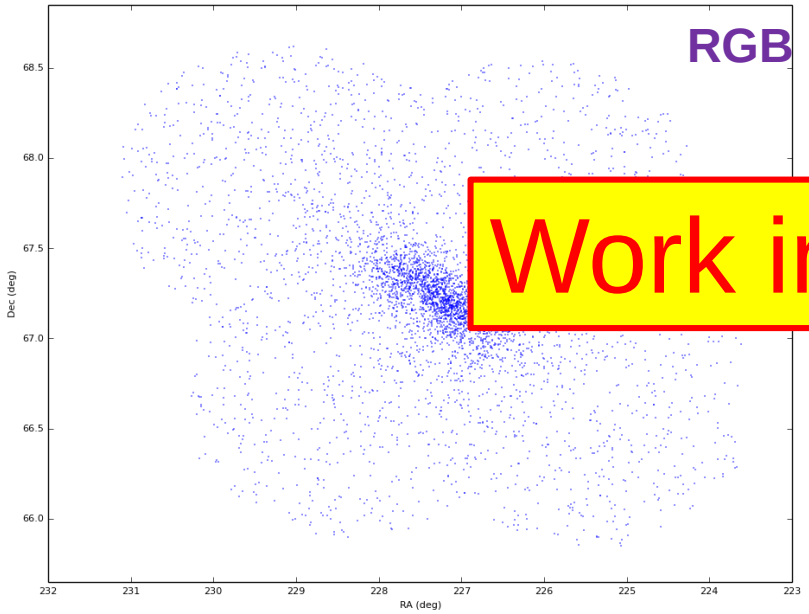


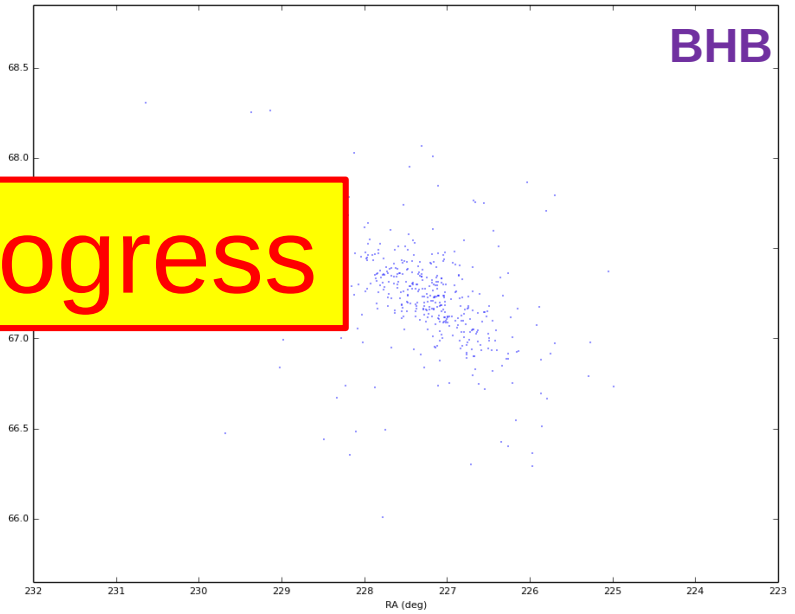
Ursa Minor
(Komiyama+)



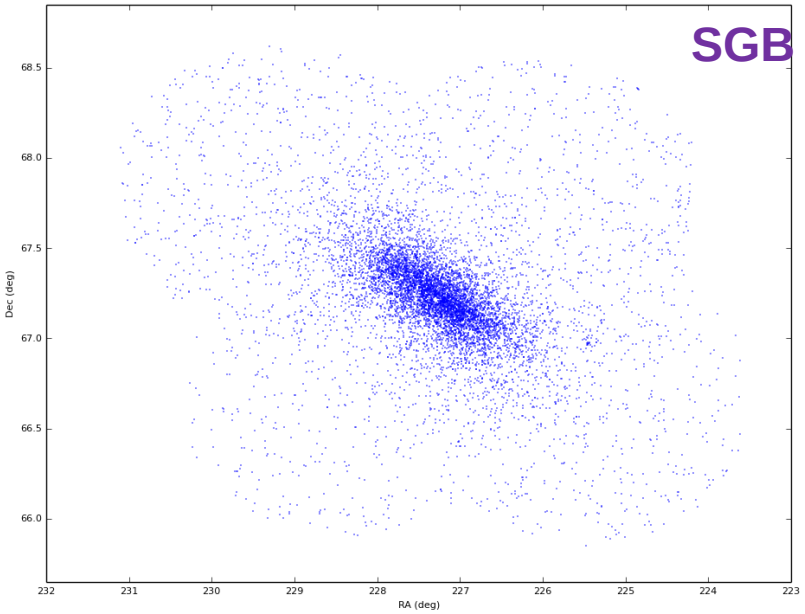


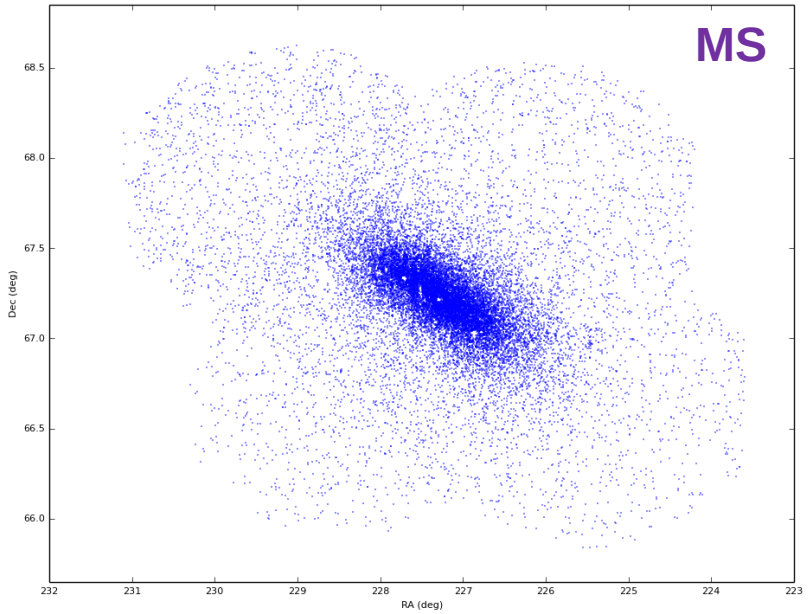
Spatial Distribution of Stellar Population





Work in progress





Summary

- Data analysis is now in progress
  - Stellar population of substructures by combining the properties of the HB and RGB stars
- NB515 coverage is yet incomplete
  - Sampling of most likely RGBs will reveal true halo structures incl. the halo edge.
  - Required for PFS targets
- HSC imaging of the MW satellites is in progress
  - Required for PFS targets