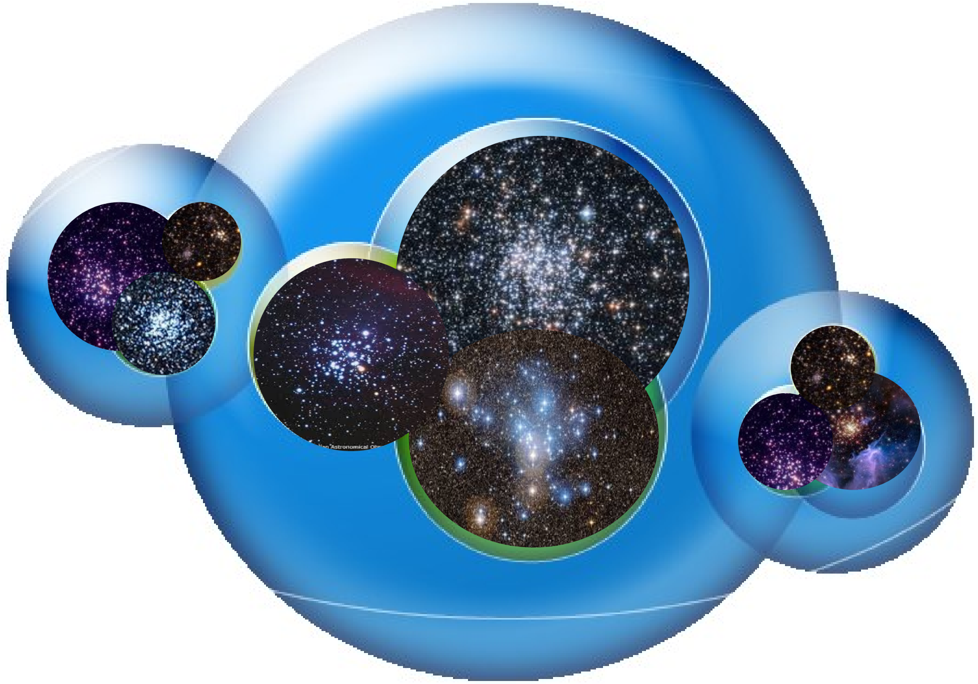

The Consortium

Co-PIs: Gerry Gilmore & Sofia Randich

Steering group: 12 members+ CoPIs

450++ Co-Is, 95+ institutes

20 WGs

1 The Gaia-ESO Survey

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http://gaia-eso.eu (public survey pages)

http://great.ast.cam.ac.uk/GESwiki/GESHome

http://casu.ast.cam.ac.uk/gaiaeso/

http://ges.roe.ac.uk (public archive)

Gaia-ESO Survey in a Nutshell

FLAMES: Giraffe & UVES parallel

300 (240+60) nights over 5 (4+1) years

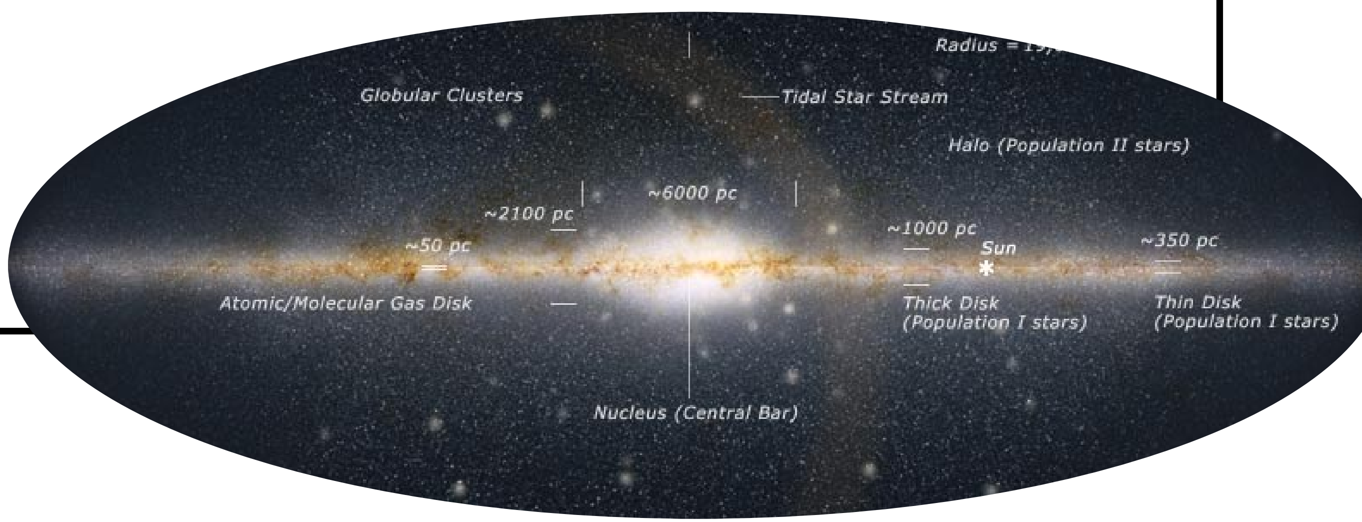
Started in 12/2011 (P88)

$>10^5$ stars

All populations of the MW:

- Halo
- Bulge
- Thick & Thin discs
- Open Clusters

+ calibrators



Gaia-ESO Survey in a Nutshell

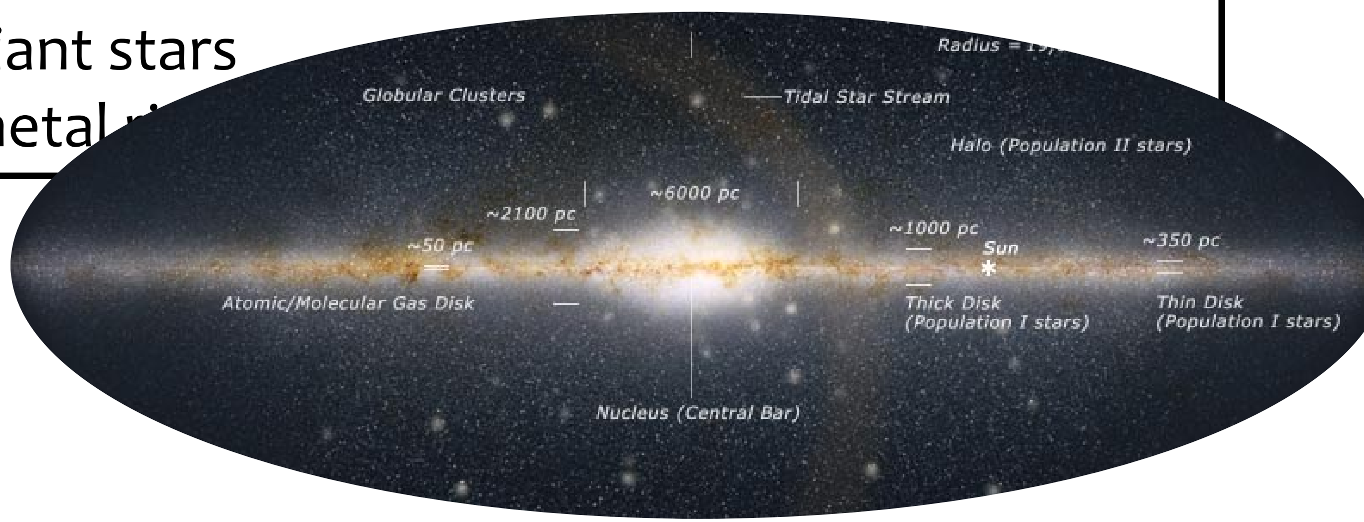
FLAMES: Giraffe & UVES parallel

300 (240+60) nights over 5 (4+1) years

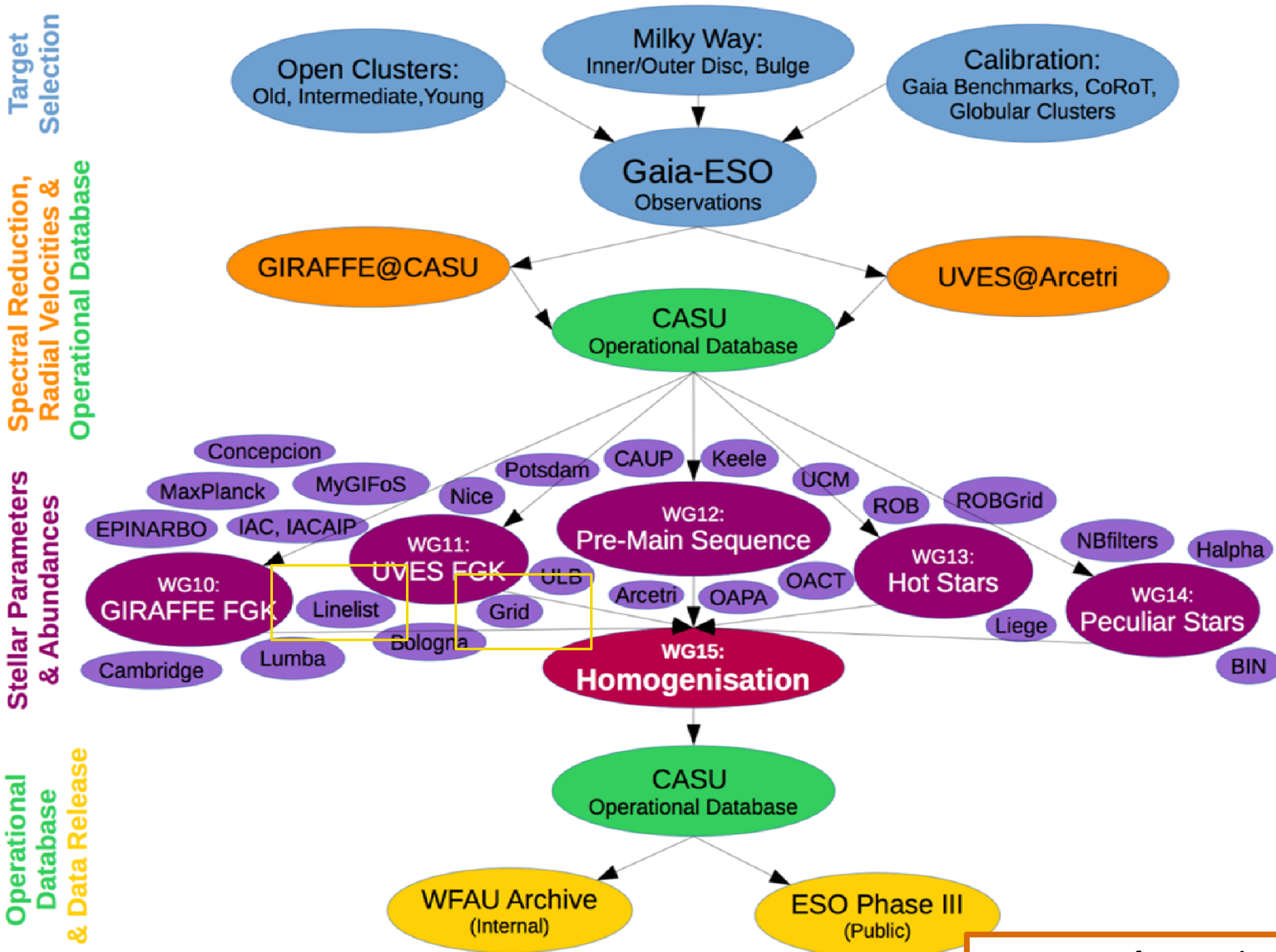
Started in 12/2011 (P88)

All stellar types:

- O-type → M dwarfs
- PMS → MS → giant stars
- metal-poor → metal

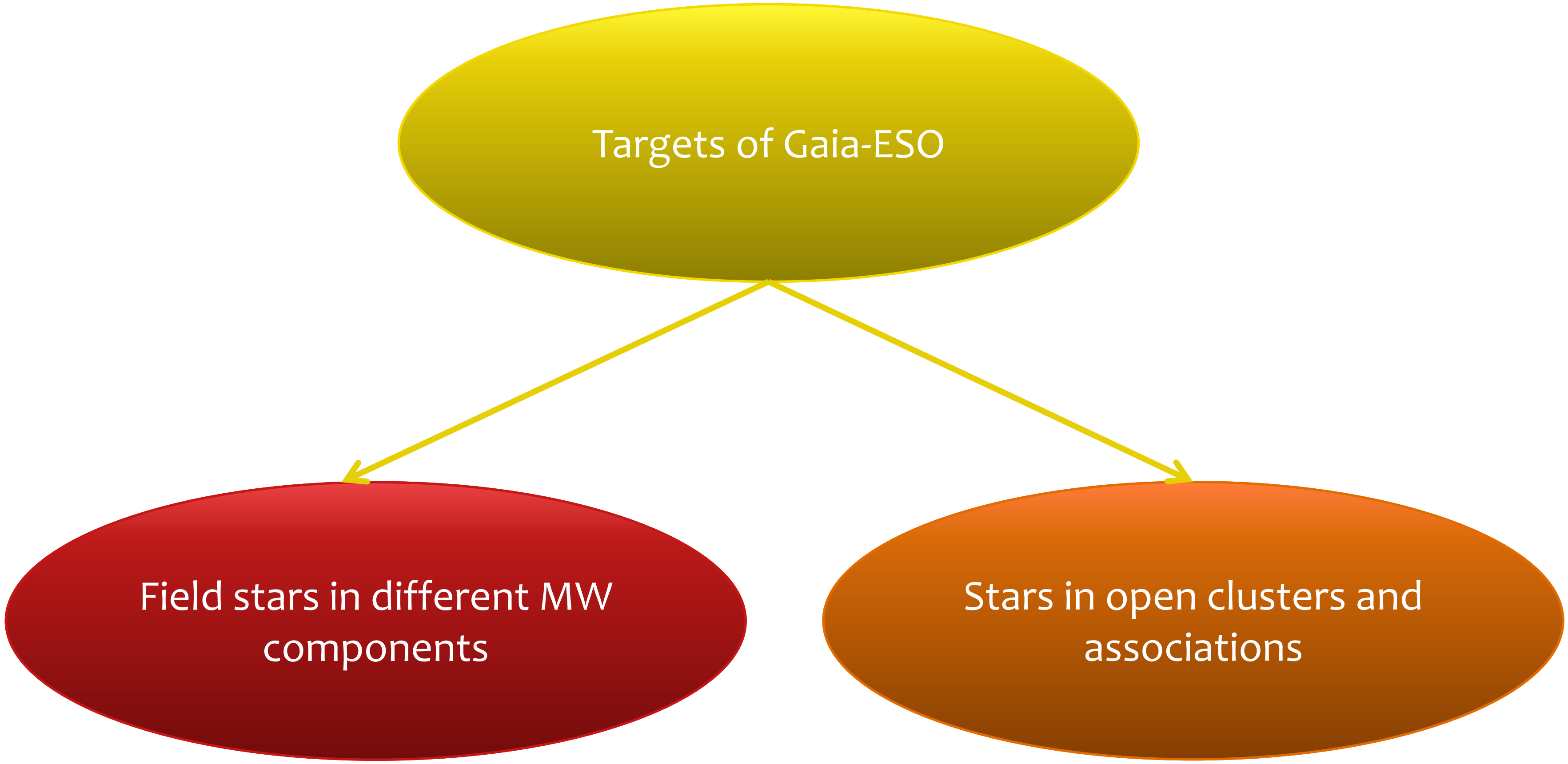


Gaia-ESO Survey in a Nutshell



Courtesy of C. Worley

Gaia-ESO Survey in a Nutshell



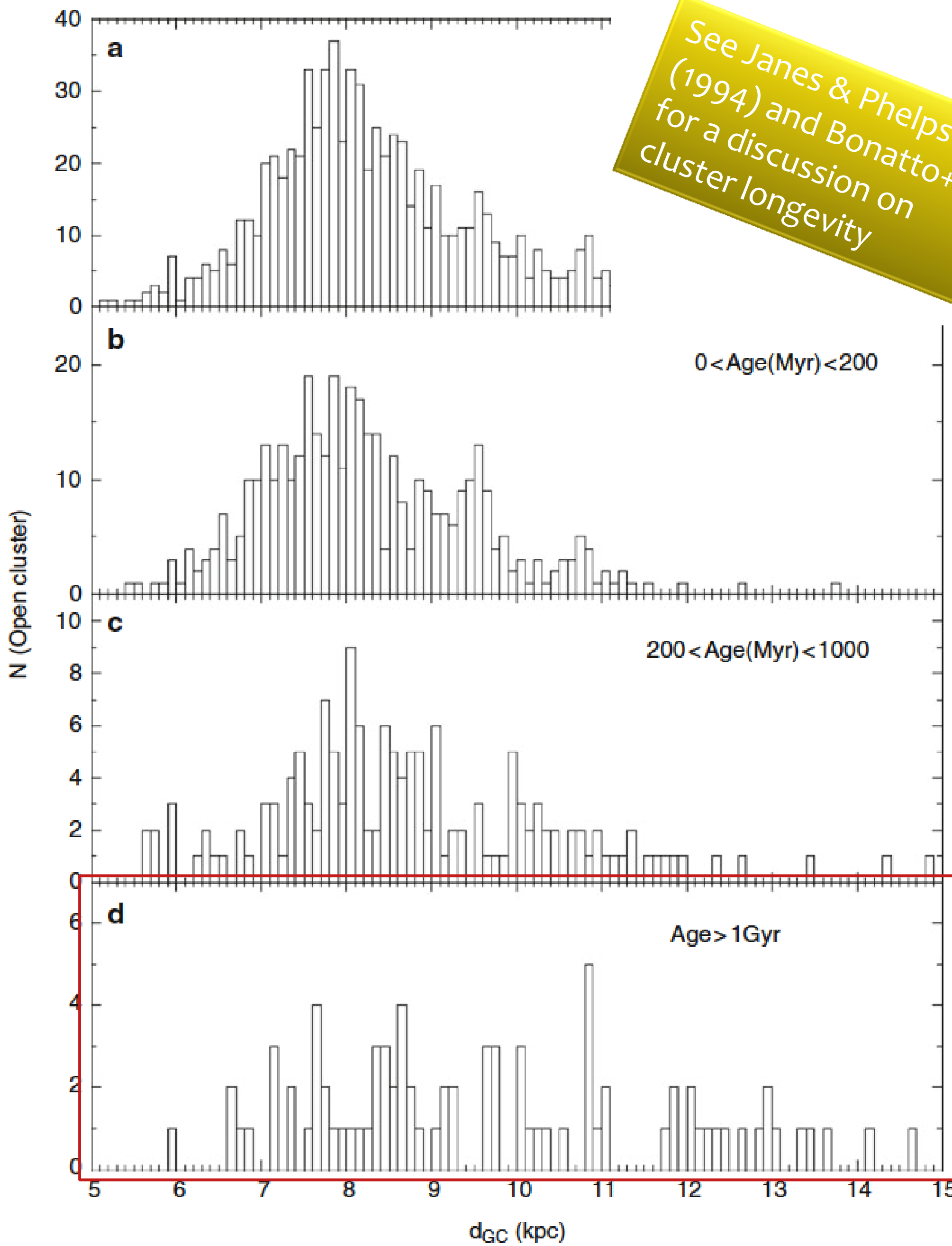
- → even more new candidates (~500) in the inner disc (see VISTA Survey, Barbà et al. 2015)
-
-
-

http://www.univie.ac.at/webda/
http://www.astro.iag.usp.br/~wilton/

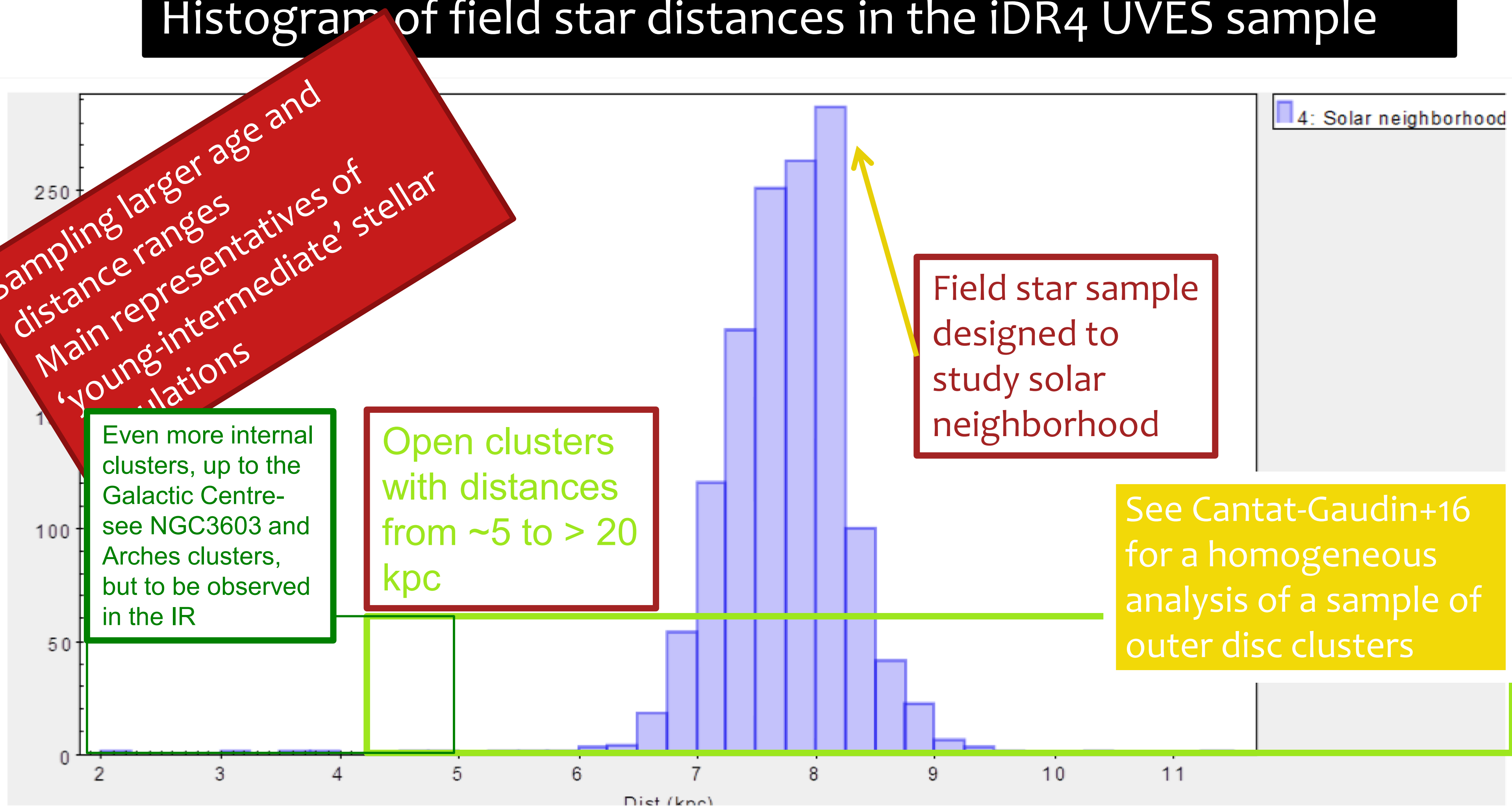
From: “Open clusters and their role in the Galaxy”
E. Friel 2013

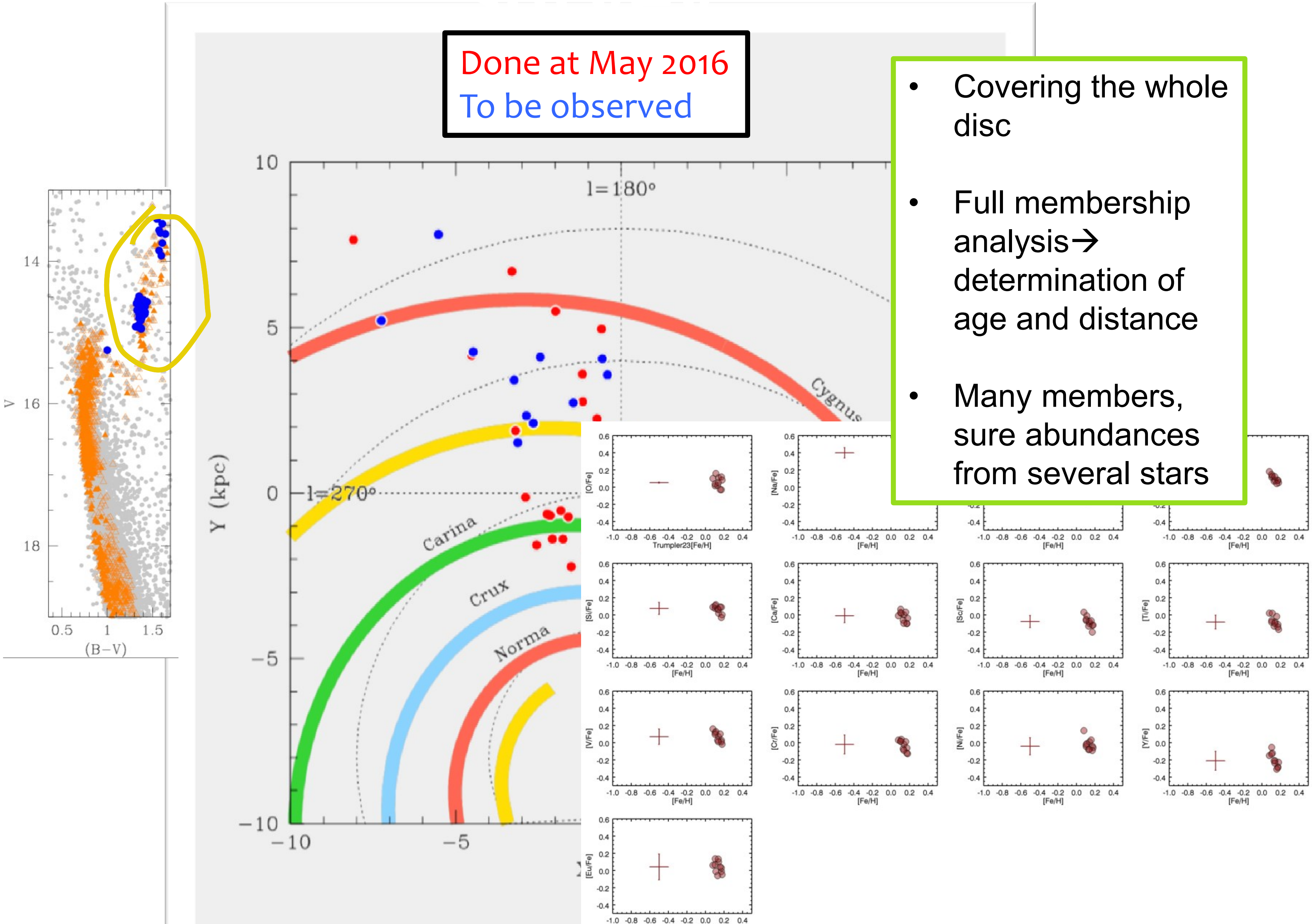
The internal and external disruptive factors are so effective that one does not expect to see clusters with ages greater than ~1Gyr !

See Janes & Phelps (1994) and Bonatto+06 for a discussion on cluster longevity

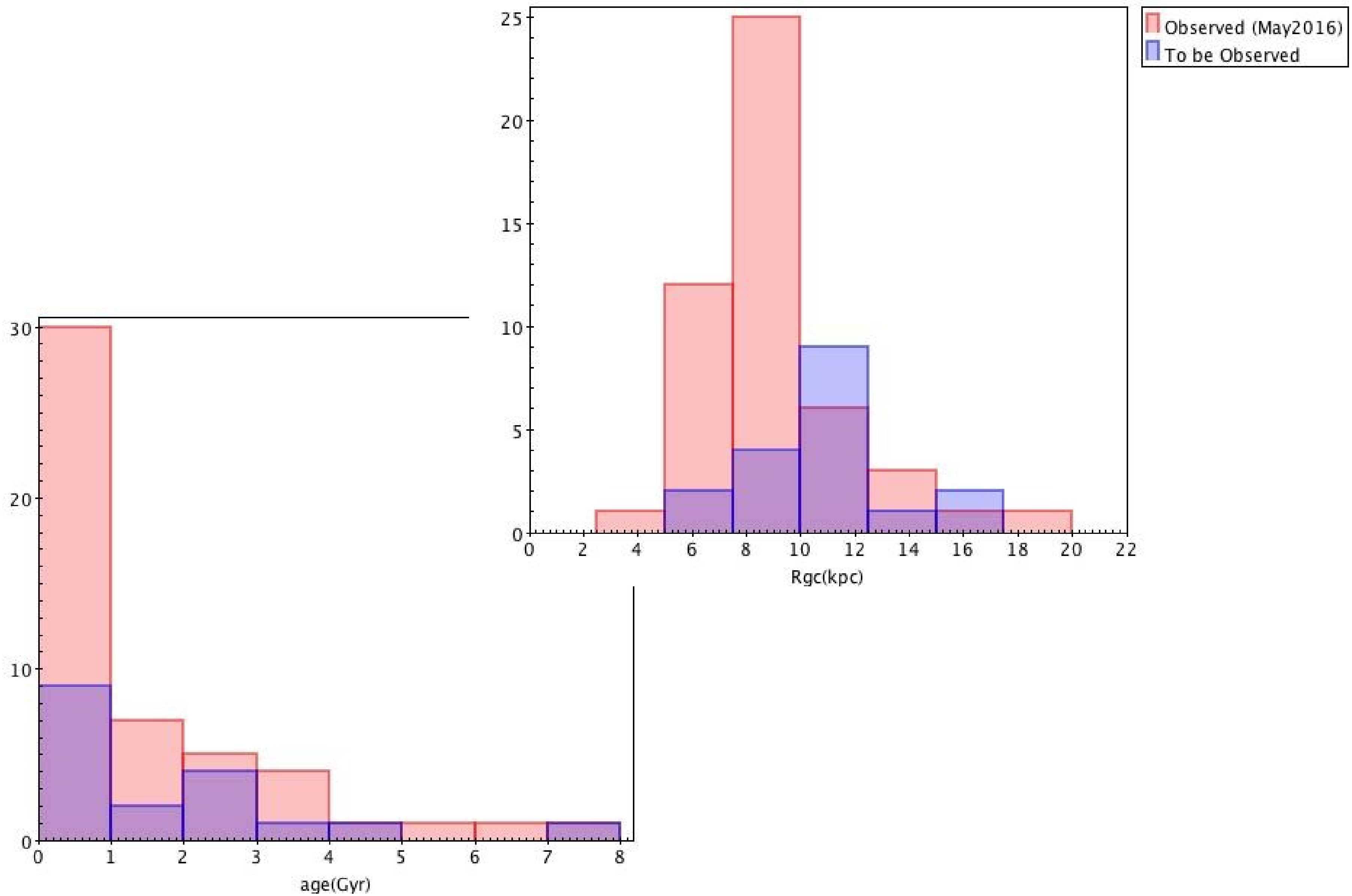


Histogram of field star distances in the iDR4 UVES sample



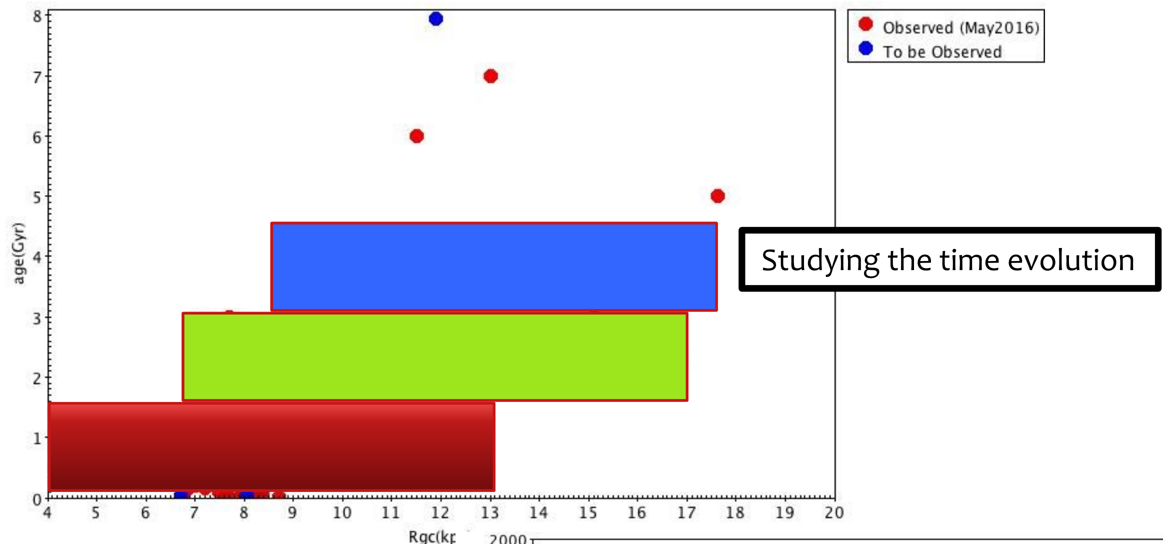


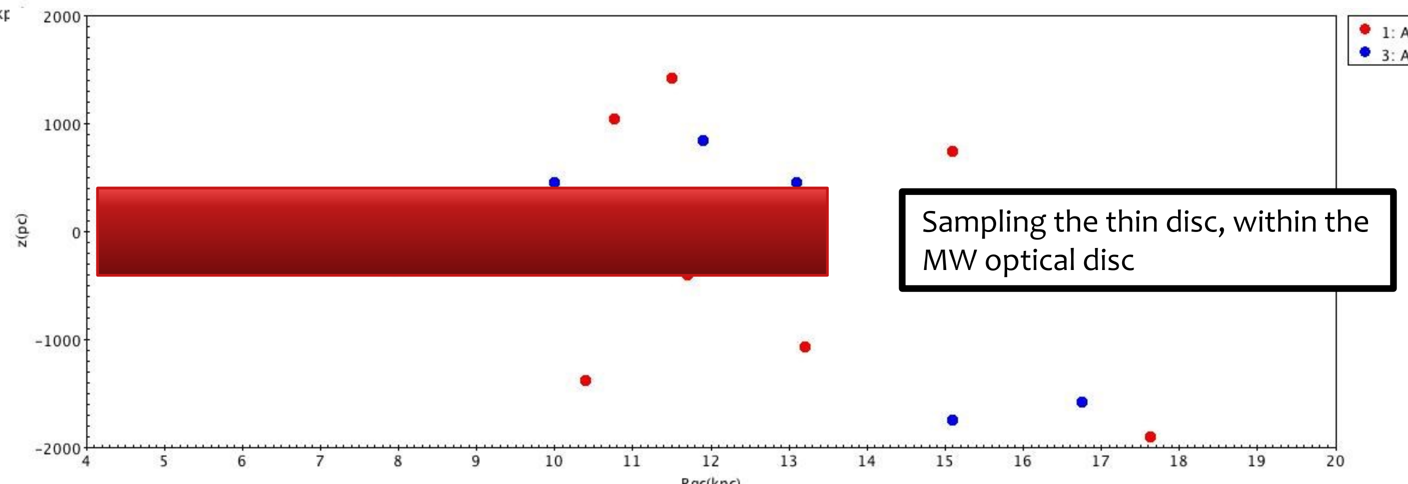
- Covering the whole disc
- Full membership analysis→ determination of age and distance
- Many members, sure abundances from several stars



Observed (May2016)
To be Observed
Rgc(kpc)
age(Gyr)

Done at May 2016
To be observed

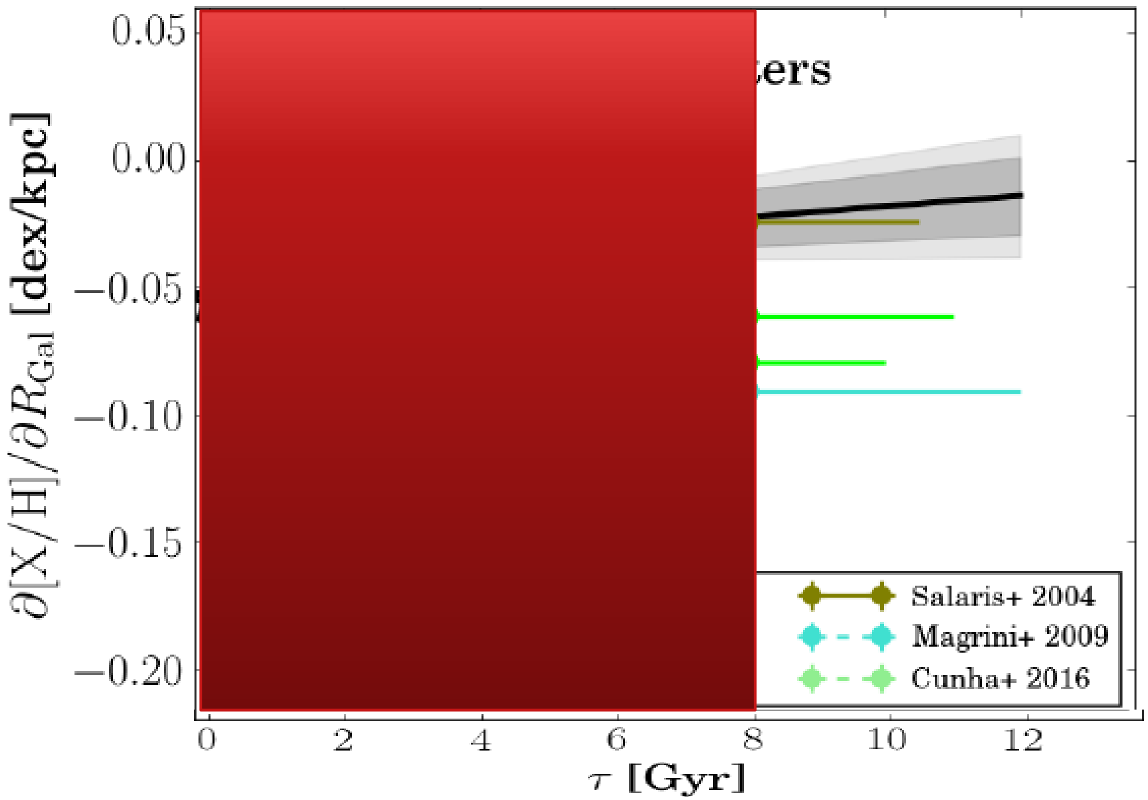




Radial metallicity distribution with OCs: open questions

Observations of Open Clusters are valuable tools to answer to these questions

Radial metallicity distribution: open questions



From Anders+16

- Thin disc population
- Age < 8 Gyr
- Binning
- Altitude

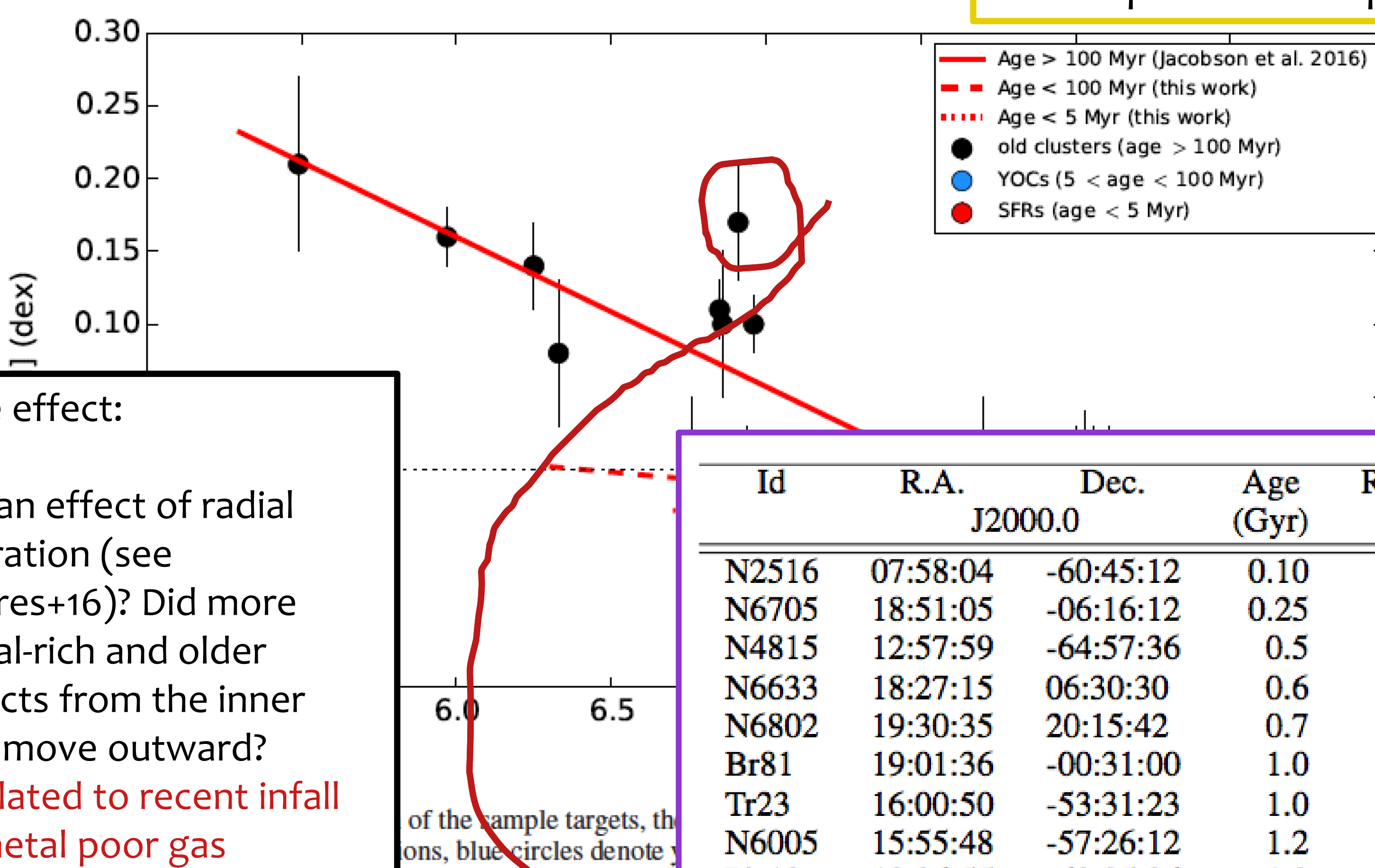
With the exception of Salaris+04 (based of 38 clusters, not including the youngest ones), OCs points towards a mild flattening with time of the radial metallicity gradient → larger/homogeneous samples are needed to confirm (or not) the literature results → **the final GES sample will give important contributions**

Some preliminary results:

Comparing intermediate-age clusters with very young clusters and star formation regions (Age < 0.1 Gyr)

From Spina et al. in prep.

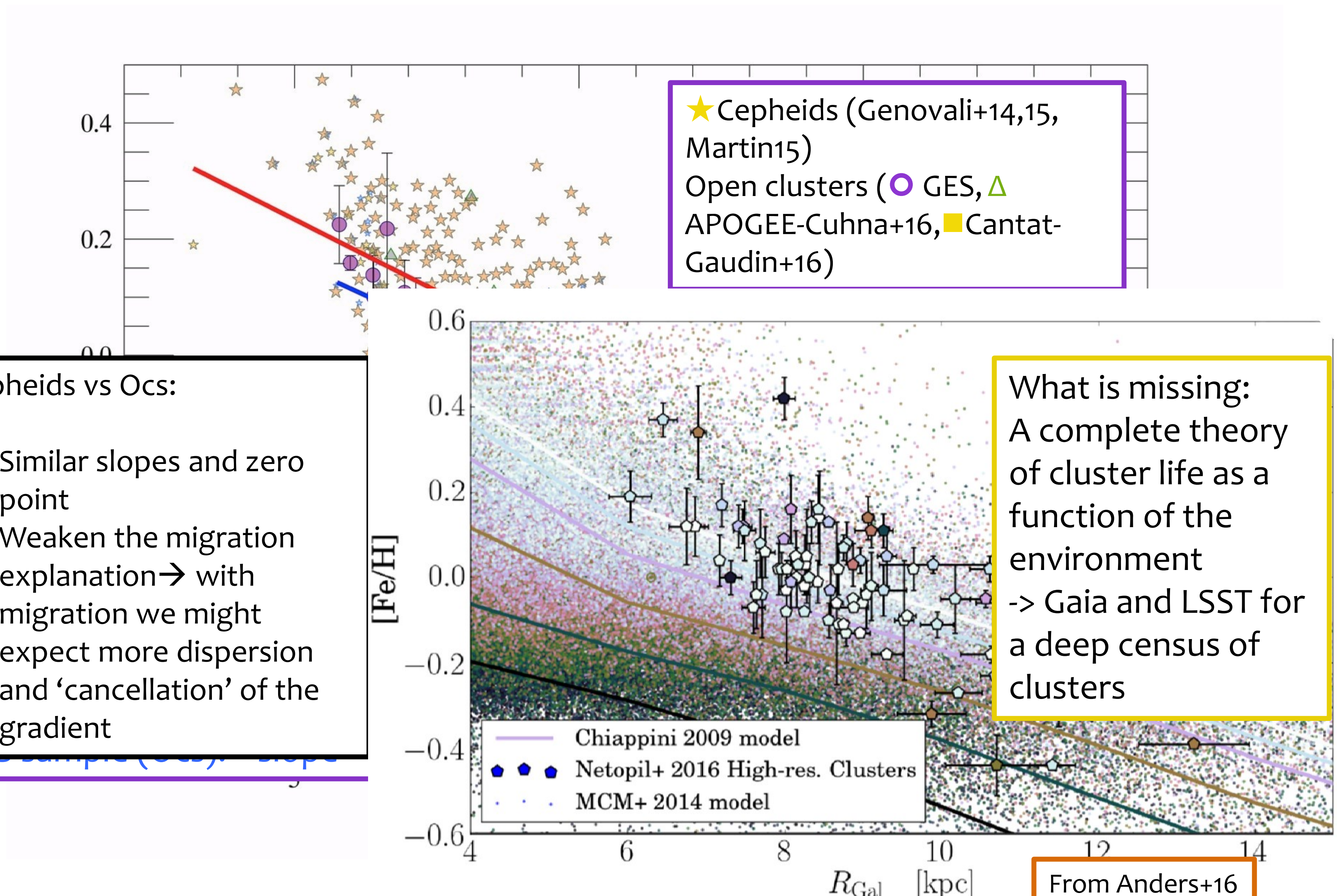
L. Spina et al.: Chemical composition of four star forming region



Id	R.A.	Dec.	Age	R_{GC}(a)	Z
	J2000.0		(Gyr)	(kpc)	(pc)
N2516	07:58:04	-60:45:12	0.10	8.0	-110
N6705	18:51:05	-06:16:12	0.25	6.4	-90
N4815	12:57:59	-64:57:36	0.5	6.9	-90
N6633	18:27:15	06:30:30	0.6	7.7	55
N6802	19:30:35	20:15:42	0.7	7.1	30
Br81	19:01:36	-00:31:00	1.0	5.8	-110
Tr23	16:00:50	-53:31:23	1.0	6.4	-16
N6005	15:55:48	-57:26:12	1.2	6.0	-140
Pis18	13:36:55	-62:05:36	1.2	6.8	12
Tr20	12:39:32	-60:37:36	1.4	6.9	120
Br44			2.9	6.6	180

The age effect:

- Is it an effect of radial migration (see Andres+16)? Did more metal-rich and older objects from the inner disk move outward?
- Is related to recent infall of metal poor gas (Galactic fountains)?
- Is a selection effect due to limited statistics?



Cepheids vs Ocs:

- Similar slopes and zero point
- Weaken the migration explanation→ with migration we might expect more dispersion and ‘cancellation’ of the gradient

What is missing:
A complete theory of cluster life as a function of the environment
-> Gaia and LSST for a deep census of clusters

From Anders+16

Open clusters: not only iron

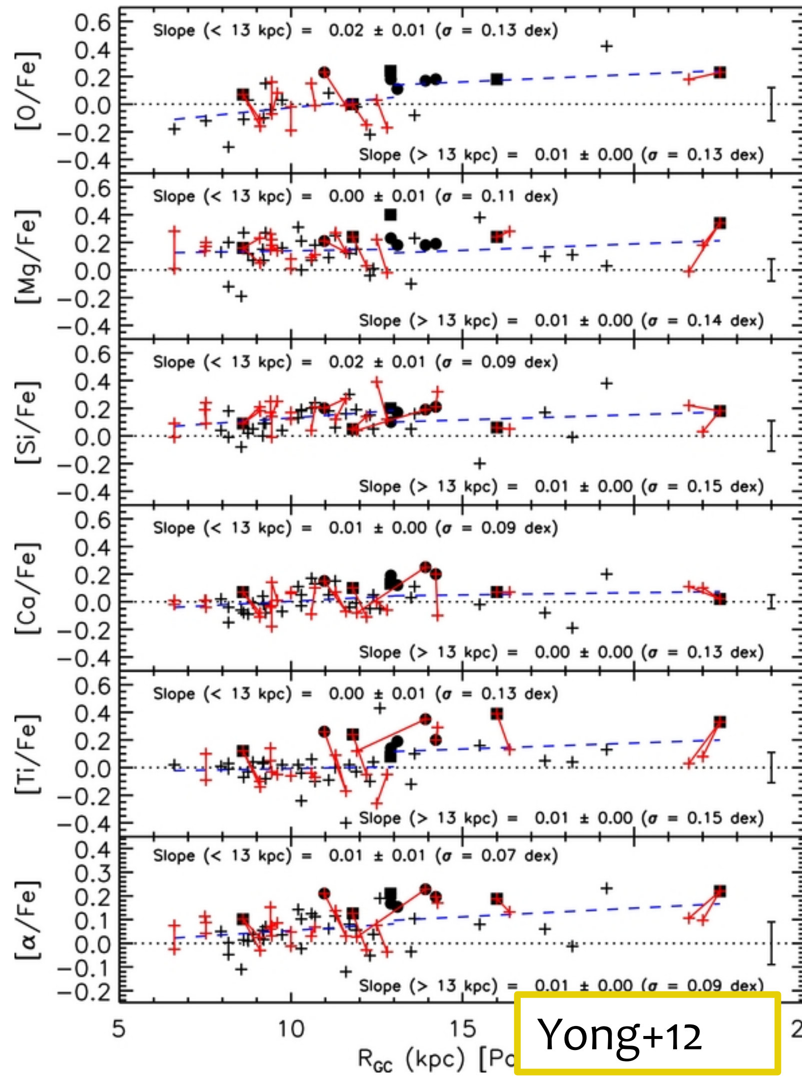
Sample of elements in GES iDR4: alpha-elements, odd-elements, iron-peak, neutron capture

Element	Main Production Site	Mechanism	Yield(SNIa/SNII)
^{16}O	Massive Stars	Helium burning	8%
^{23}Na	Massive Stars	C, Ne, H burnings	1%
^{24}Mg	Massive Stars	C, Ne burnings	10%
^{27}Al	Massive Stars	C, Ne burnings	7%
^{28}Si	Massive Stars	explosive and non-explosive O burning	60%
^{40}Ca	Massive Stars	explosive and non-explosive O burning	67%
^{45}Sc	Massive Stars	C, Ne burnings, α and ν-wind (neutrino-powered wind)	49%
^{48}Ti	Massive Stars and SNIa	explosive Si burning and SNIa with He detonation	63%
^{51}V	Massive Stars and SNIa	explosive Si and O burnings, SNIa with He detonation, and α and ν	88%
^{52}Cr	Massive Stars and SNIa	explosive Si burning, SNIa with He detonation, and α	84%
^{55}Mn	Massive Stars and SNIa	explosive Si burning, SNIa, and ν-wind	96%
^{56}Fe	Massive Stars and SNIa	explosive Si burning and SNIa	88%
^{58}Ni	Massive Stars (and SNIa)	α (α-rich freeze-out from nuclear statistical equilibrium) and SNIa	75%
^{59}Co	Massive Stars and SNIa	He-burning s-process, α, SNIa, and ν	99%
^{63}Cu	Massive Stars	He-burning s-process, C and Ne burning	73%
^{64}Zn	Massive Stars	He-burning s-process, α and ν-wind	51%
^{50}Y	Massive Stars	He-burning s-process, and ν-wind	–
^{90}Zr	Massive Stars	He-burning s-process	–
^{138}Ba	Low mass	s-process	–
^{153}Eu	Massive Stars	ν-wind	–

α-elements

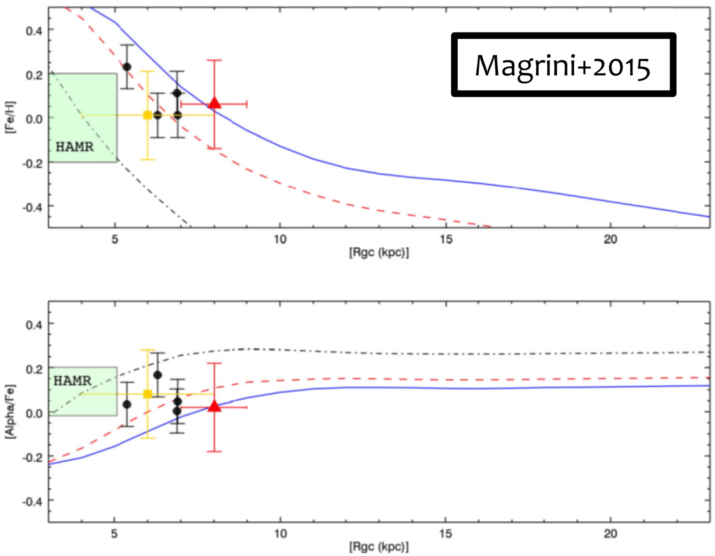
iron

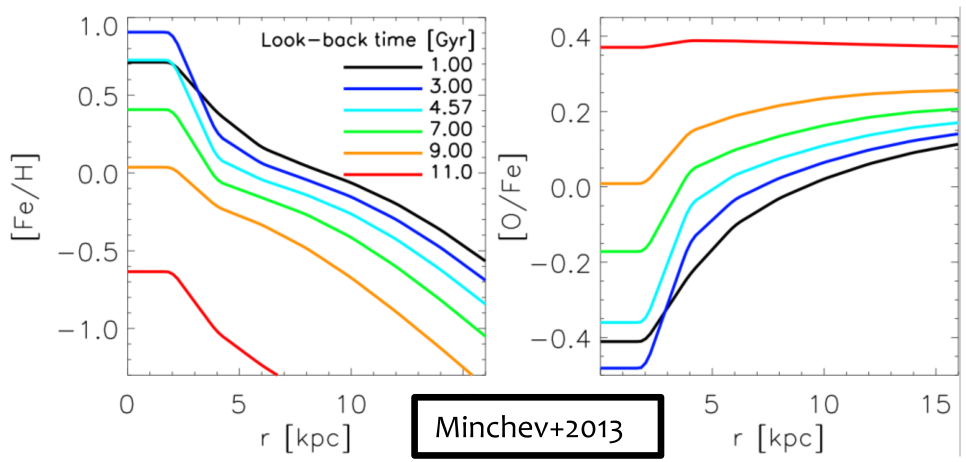
α/Fe as a cosmic clock of SF



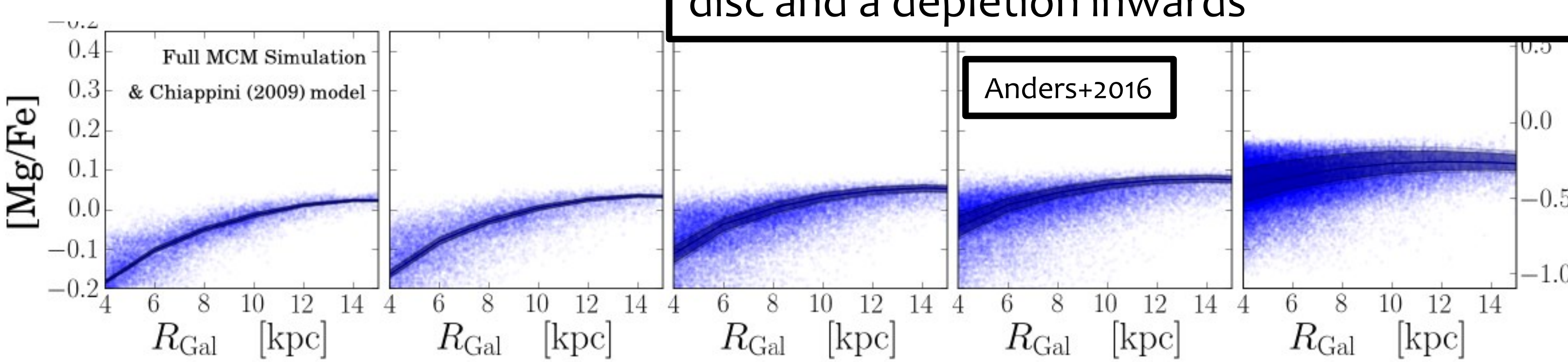
Yong+12

Form ‘classical’ chemical evolution models to chemo-dynamical models

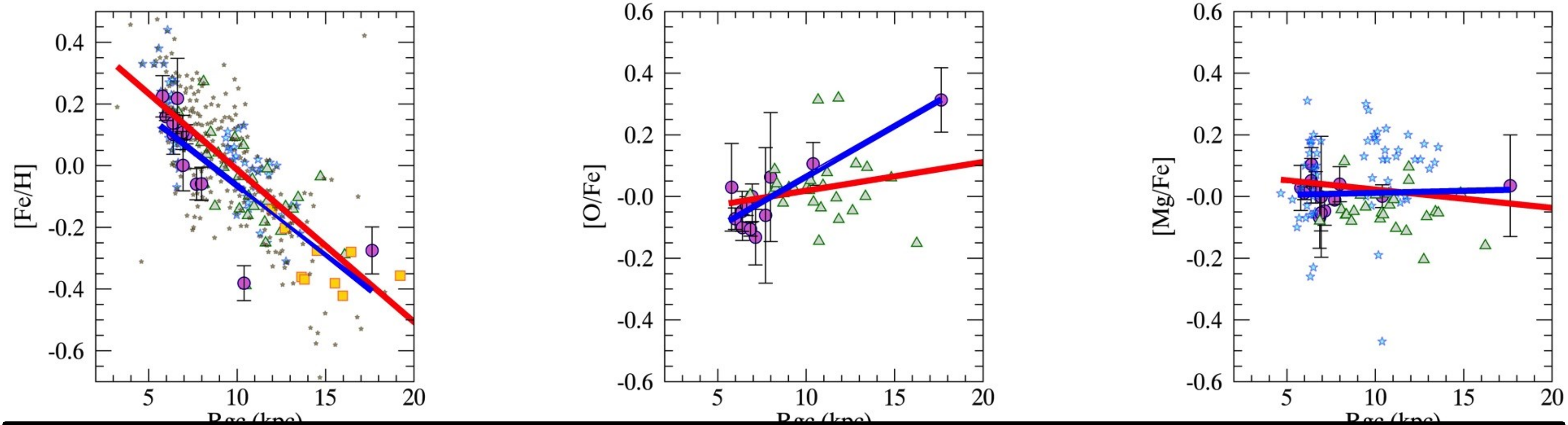




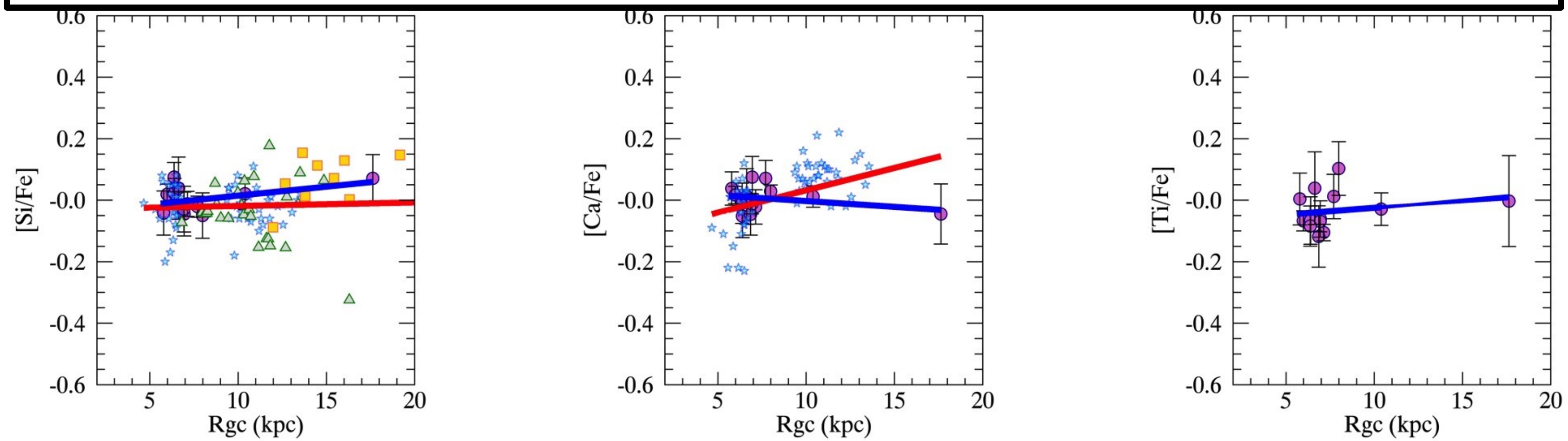
They predict an enhancement towards the outer disc and a depletion inwards

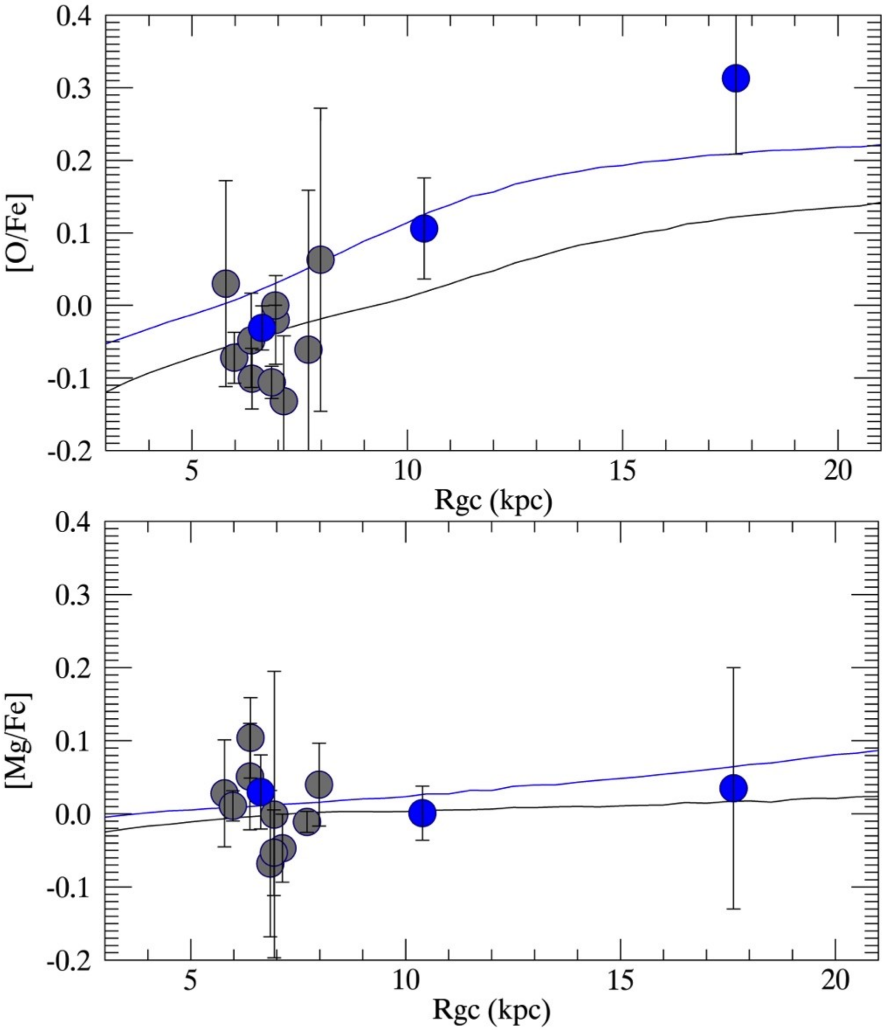


GES observations (+literature—Ocs and Cepheids)

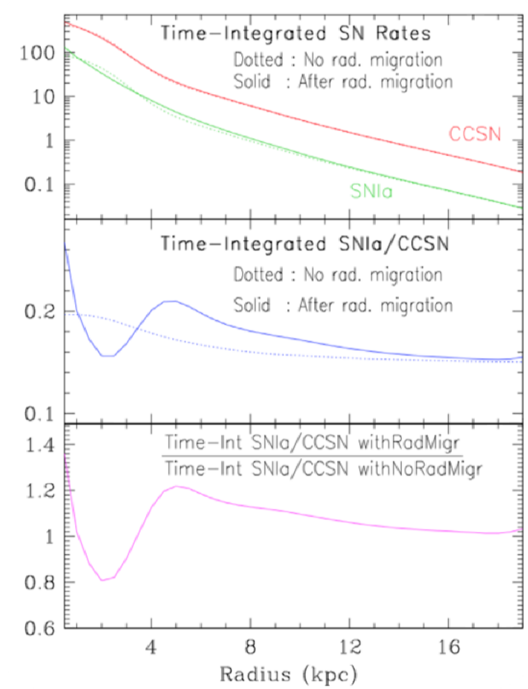


No apparent variation with R_{GC} for most of the α/Fe gradient, only O/Fe shows a non negligible increase with R_{GC}

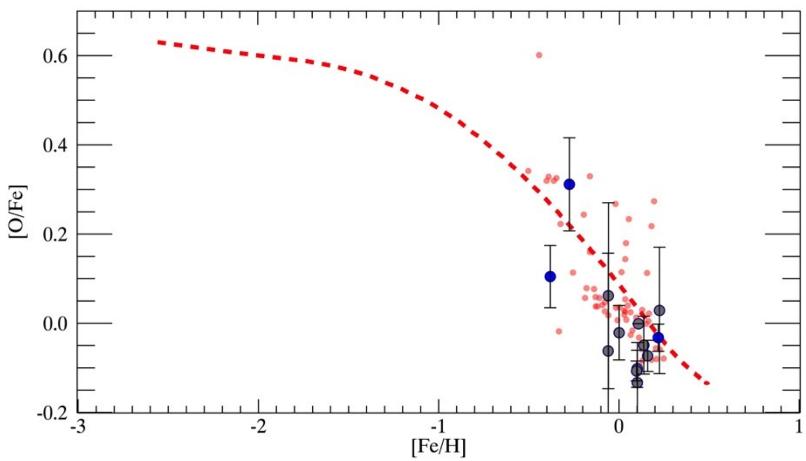


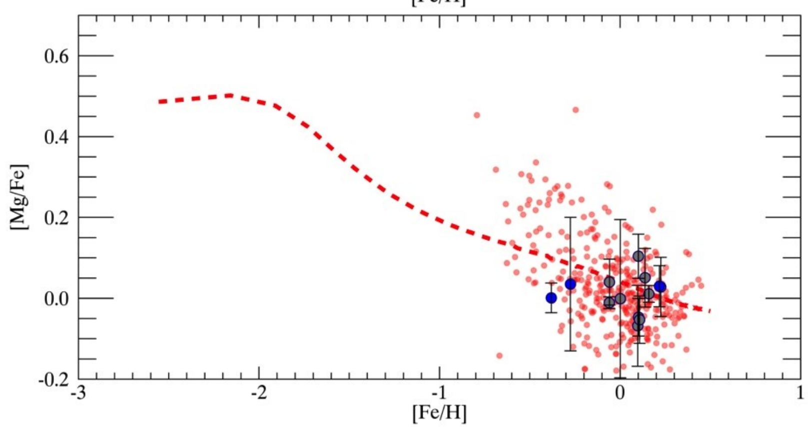


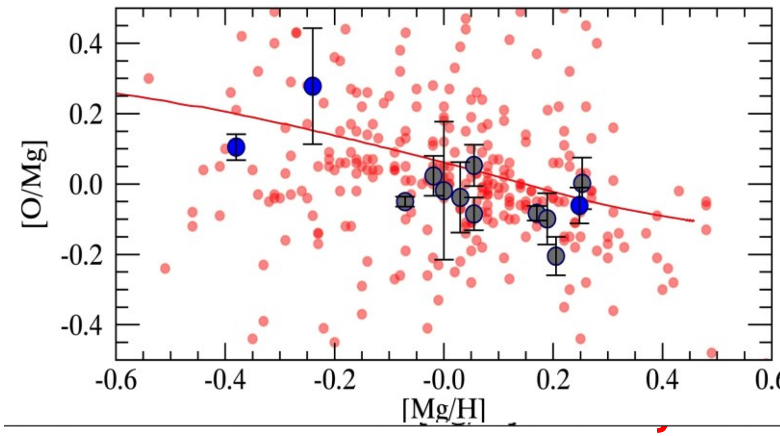
[O/Fe]
Rgc (kpc)
[Mg/Fe]
Rgc (kpc)



Time-Integrated SN Rates
Dotted : No rad. migration
Solid : After rad. migration
CCSN
SNIa
Time-Integrated SNIa/CCSN
Dotted : No rad. migration
Solid : After rad. migration
Time-Int SNIa/CCSN withRadMigr
Time-Int SNIa/CCSN withNoRadMigr
Radius (kpc)

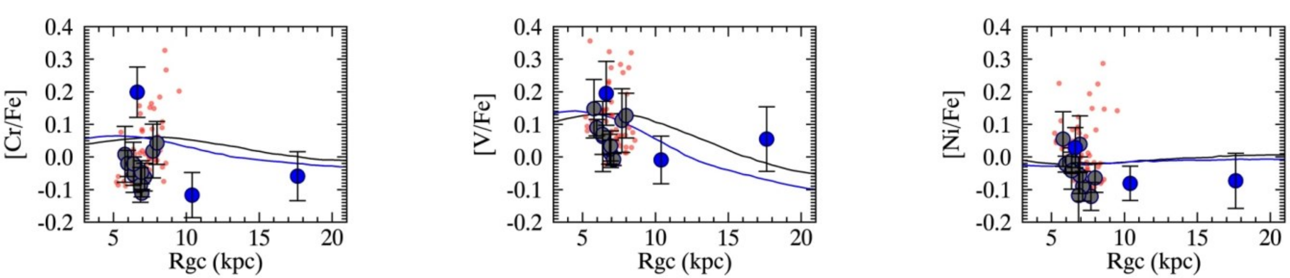






dependent yields for SNII

see Nikos Prantzos's talk form more details



- For most elements the model+metallicity dep. yields are a good representation of the observations
- For few elements, the theory remains far to reproduce the observations
- In the metallicity range of the thin disc→ no strong α/Fe is expected (when averaging the usual elements)
- O/Fe gives the highest probability to detect SFH differences
- Mg and Fe vary in lockstep in the [Fe/H]-0.5/+0.5 regime→ no good tracer of SFH