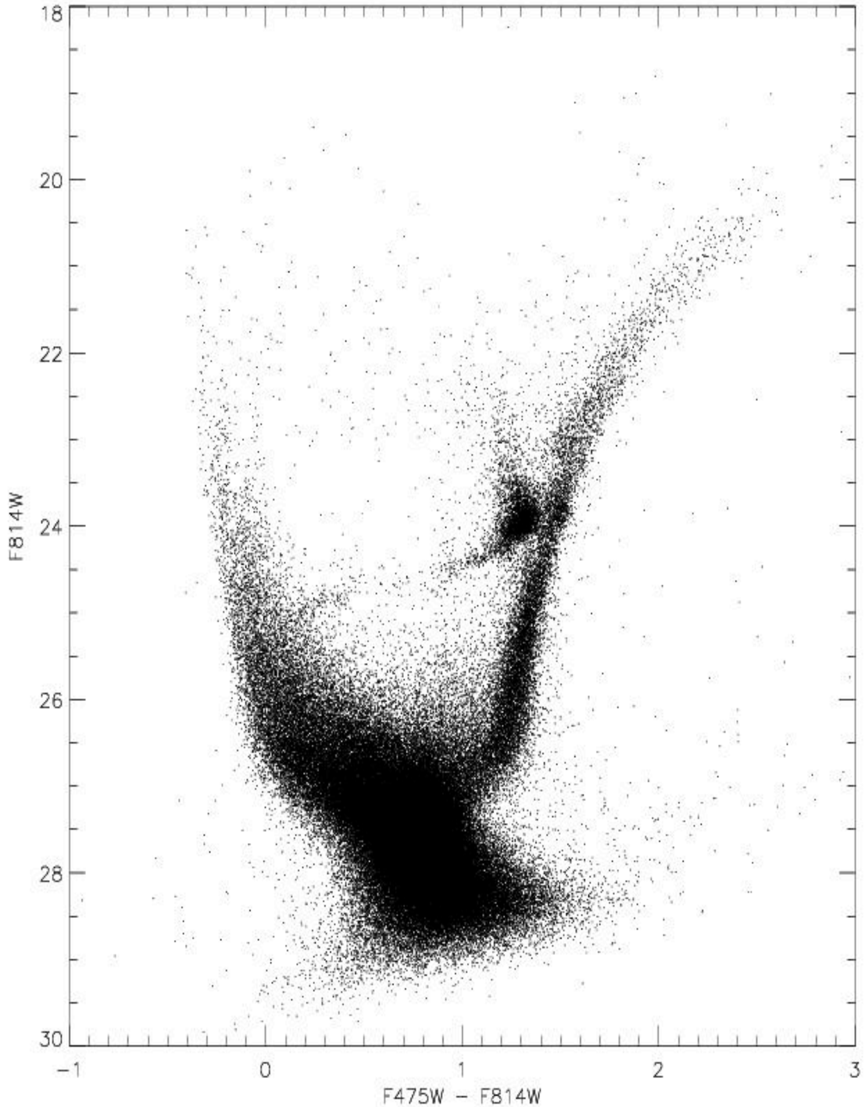
DERIVING THE STAR FORMATION HISTORY OF COMPLEX, RESOLVED STELLAR POPULATIONS WITH IAC-STAR/IAC-POP/MINNIAC

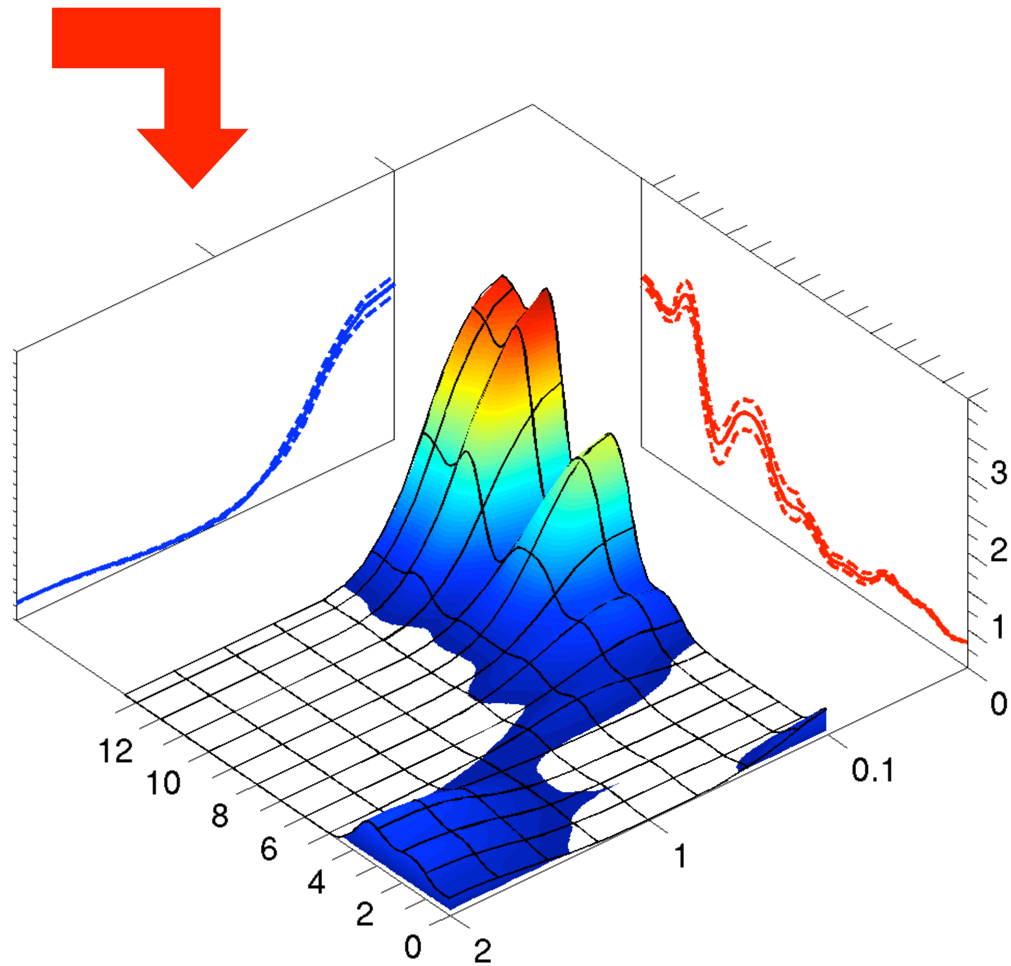
J.M. Carrasco
Maria Czekaj
Cesca Figueras
Carme Jordi
Barcelona (ICCUB - IEEC)

Antonio Aparicio
Carme Gallart
Sebastián Hidalgo
University of La Laguna (ULL)
Instituto de Astrofísica de Canarias (IAC)
La Laguna, Tenerife



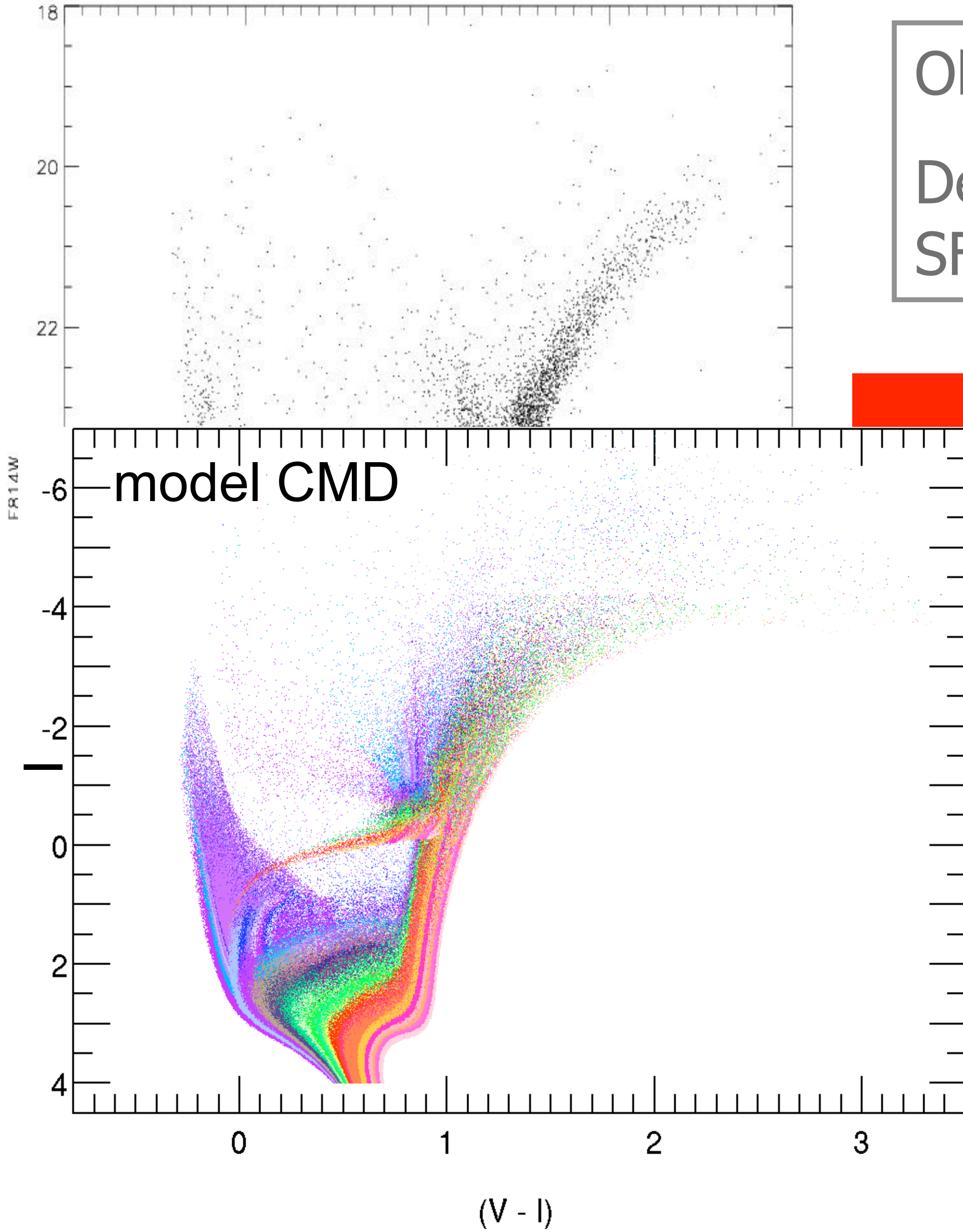
Objective:

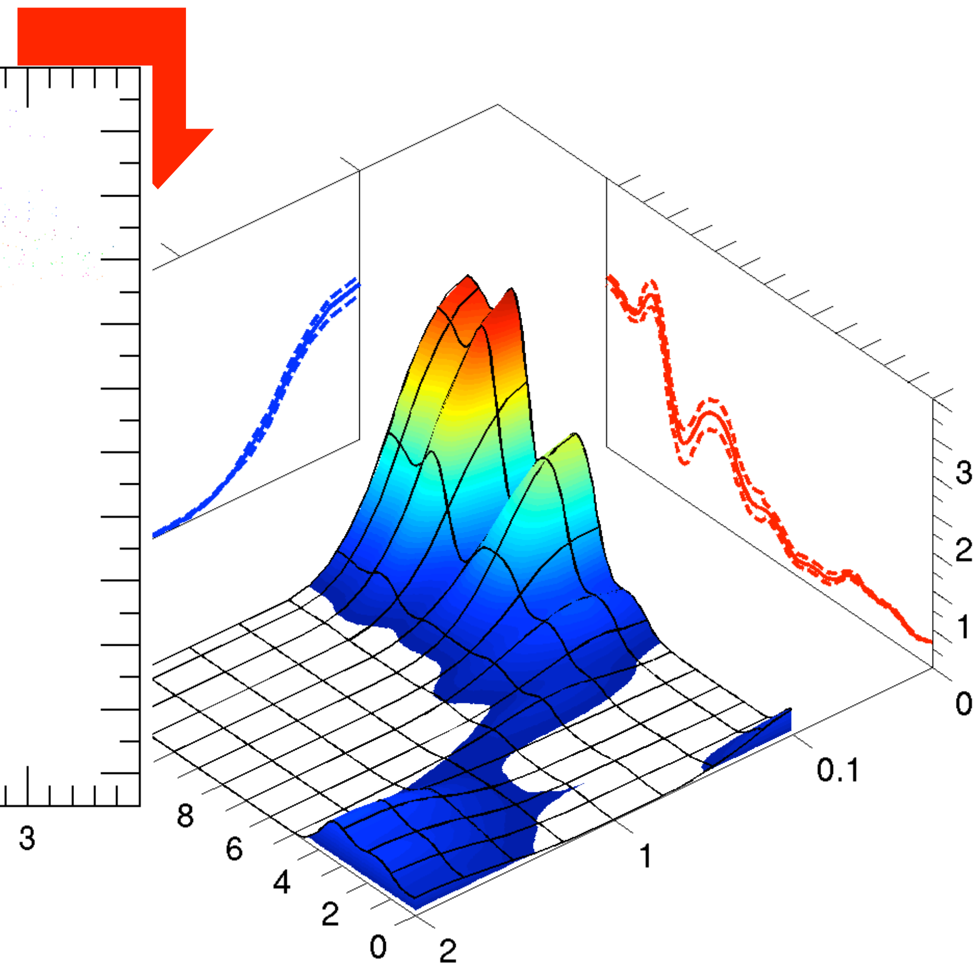
Deriving the quantitative SFH from a CMD



Objective:

Deriving the quantitative SFH from a CMD





DERIVING THE SFH: OUTLINE

I. Photometry

LCID: Daophot + Dolphot

II. Completeness tests

Synthetic stars

III. IACSTAR

Create a MODEL CMD

IV. Errors simulation

V. MINNIAC

Parametrization of the CMD

VI. IACPOP

Derive the SFH

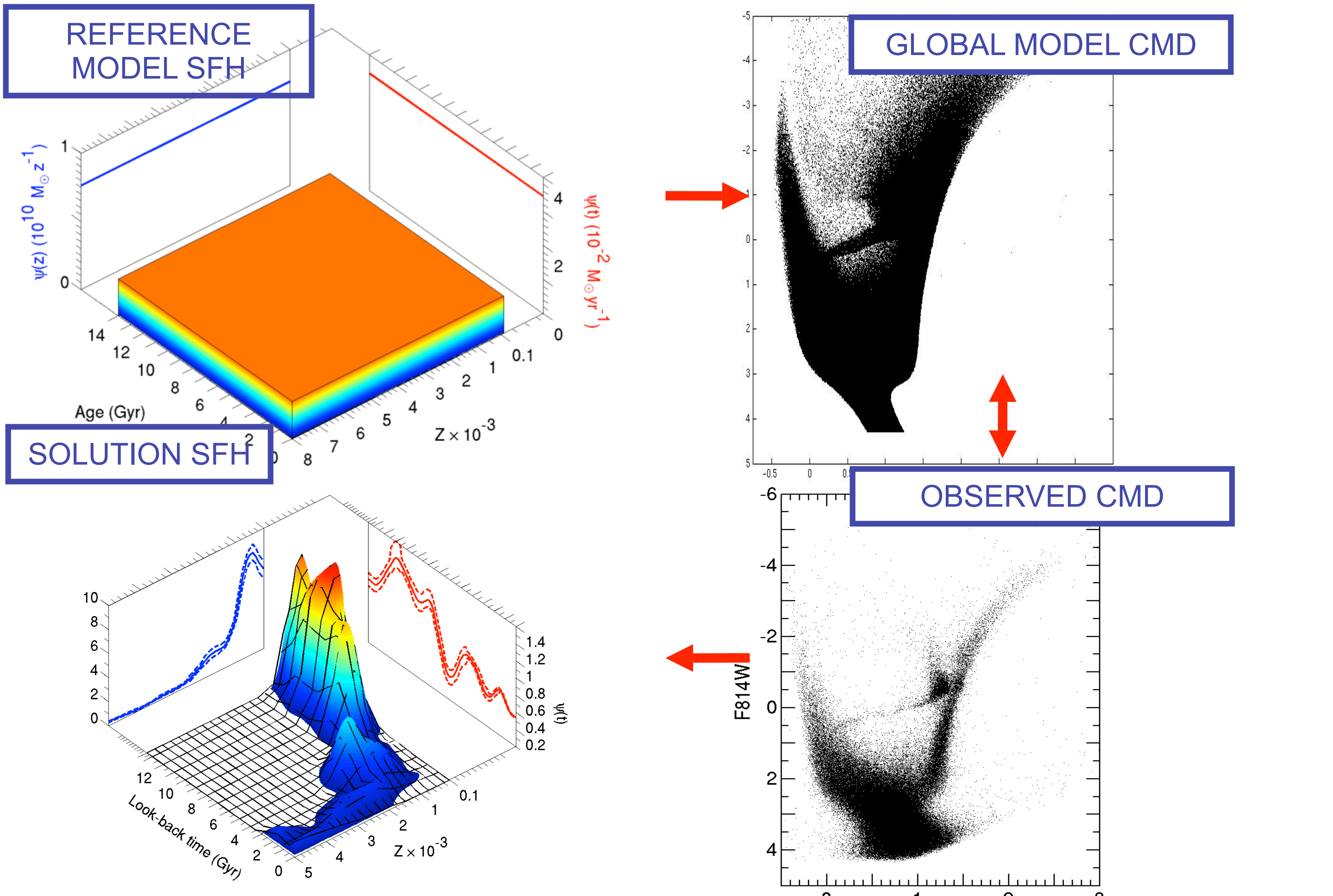
VII. MINNIAC

Visualization of the results

Three independent and complementary packages!

DERIVING THE SFH – IACPOP

http://www.iac.es/galeria/aaj/iac-pop.htm



DERIVING THE SFH - OUTLINE

1. Compute a “global” stellar population with constant SFR for wide age and metallicity ranges. It has associated a “global” mCMD

$$\psi_S(t,z) = 1$$

2. Simulate uncompleteness, crowding, blending and all the observational effects on mCMD

3. Divide the global population into several simple (age and metallicity) ones

$$\psi_i(t,z) = 1 \qquad t_i \le t < t_i + \Delta_i t \qquad z_i \le z < z_i + \Delta_i z$$

$$\psi_i(t,z) = 0 \qquad \text{otherwise}$$

4. Any SFH can be obtained as: $\psi(t,z) = \sum_i \alpha_i \psi_i(t,z)$

5. Parameterize the observational and the simple iCMDs using boxes or grid

6. The stellar distribution on the associated CMD is given by: $M_j = \sum_i \alpha_i M_{i,j}$

7. Find best solution using a merit function:

$$\chi^2 = \sum_j \frac{\left(M^j - O^j\right)^2}{O^j} \qquad \chi_\gamma^2 = \frac{\left(M_j + \min\left(M_j, 1\right) - O_j\right)^2}{O_j + 1} \qquad \chi_\nu^2 = \frac{\chi_\gamma^2}{\nu}$$

III. Create the model CMD

http://iac-star.iac.es

Aparicio & Gallart 2004

a) Stellar evolution library

BaSTI (Pietrinferni et al 2004),

Padova (Bertelli et al 1994)

b) SFR(t)

constant, 0 < T < 15 Gyr

c) Z(t)

constant, 0.0001 < Z < 0.005

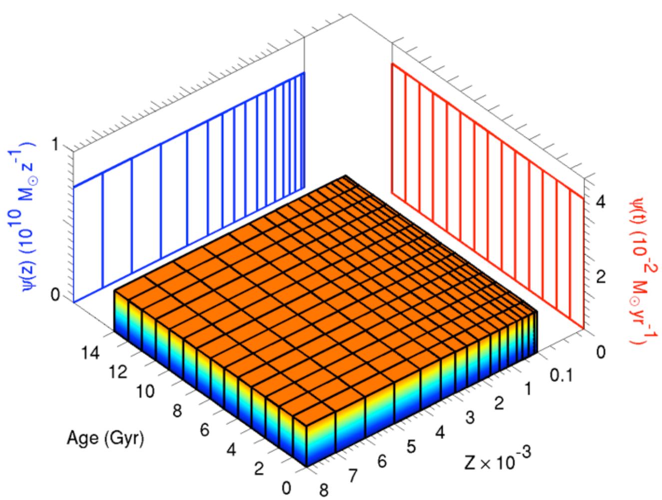
d) IMF

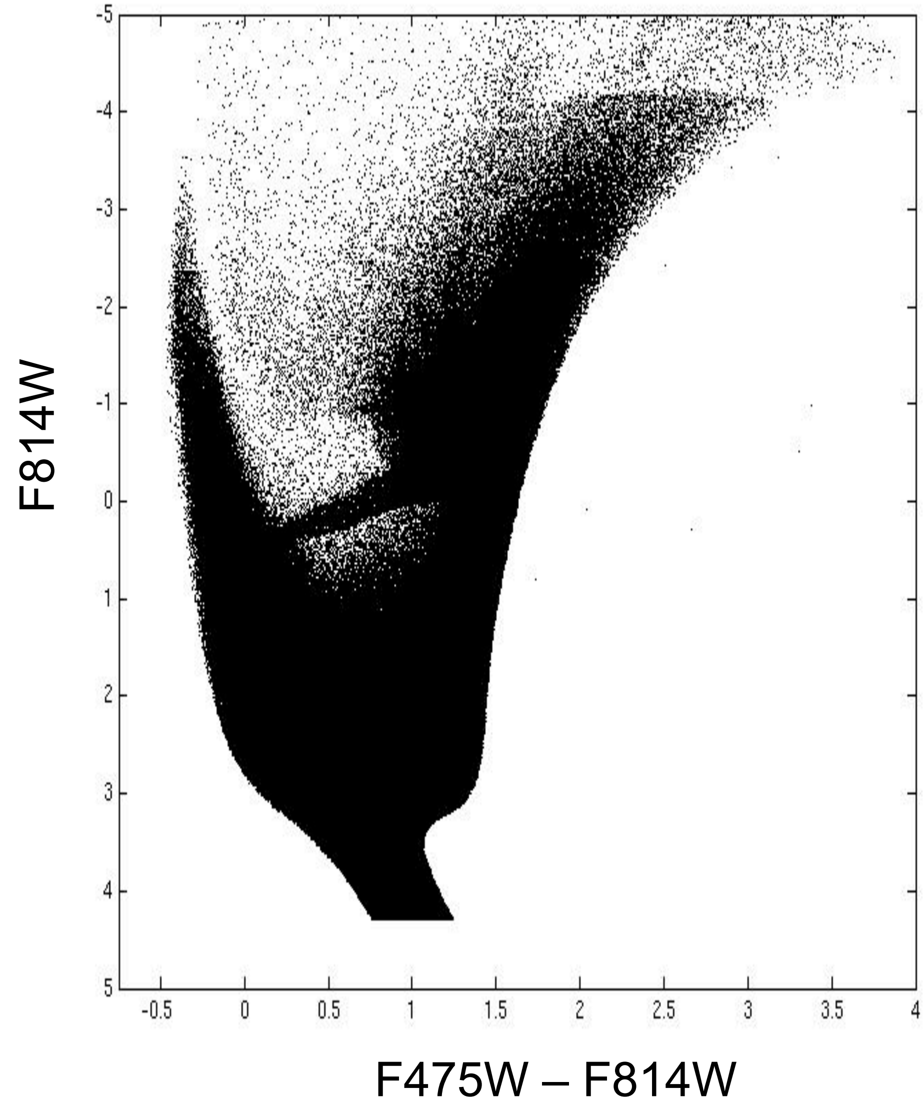
Kroupa (2001)

e) Binary fraction β

60%

f) DM (TRGB, RR Lyrae), **E(B-V)**





III. Create the model CMD

http://iac-star.iac.es

Aparicio & Gallart 2004

a) **Stellar evolution library**
BaSTI (Pietrinferni et al 2004),
Padova (Bertelli et al 1994)

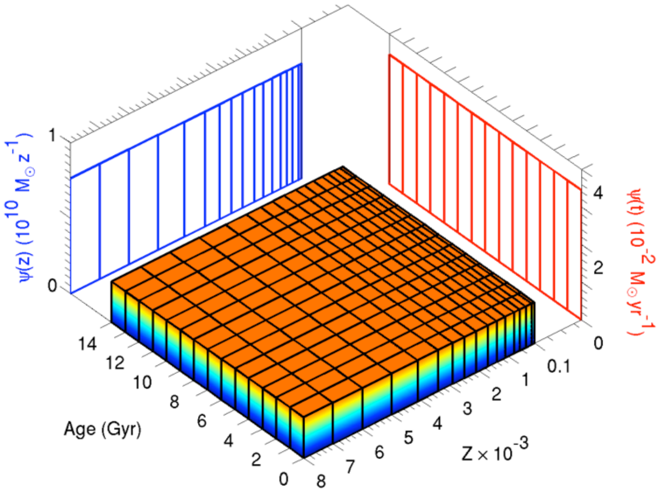
b) **SFR(t)**
constant, 0 < T < 15 Gyr

c) **Z(t)**
constant, 0.0001 < Z < 0.005

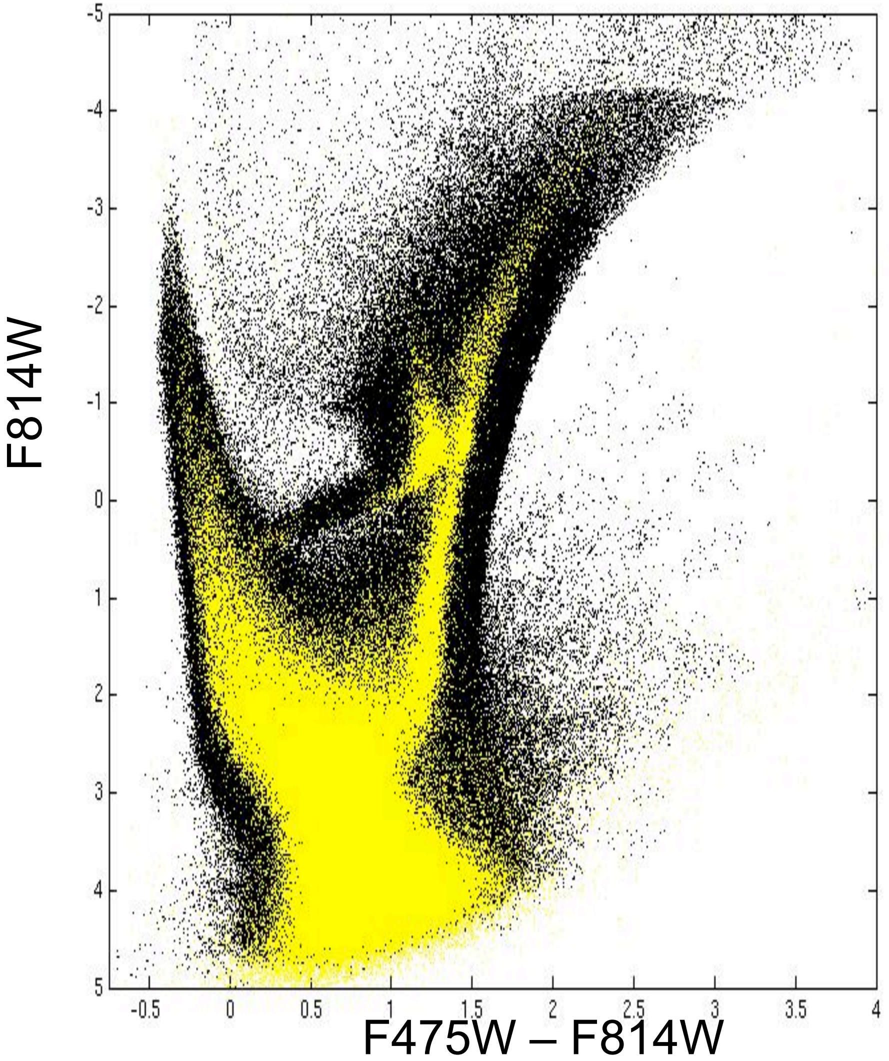
d) **IMF**
Kroupa (2001)

e) **Binary fraction β**
60%

f) **DM** (TRGB, RR Lyrae), **E(B-V)**

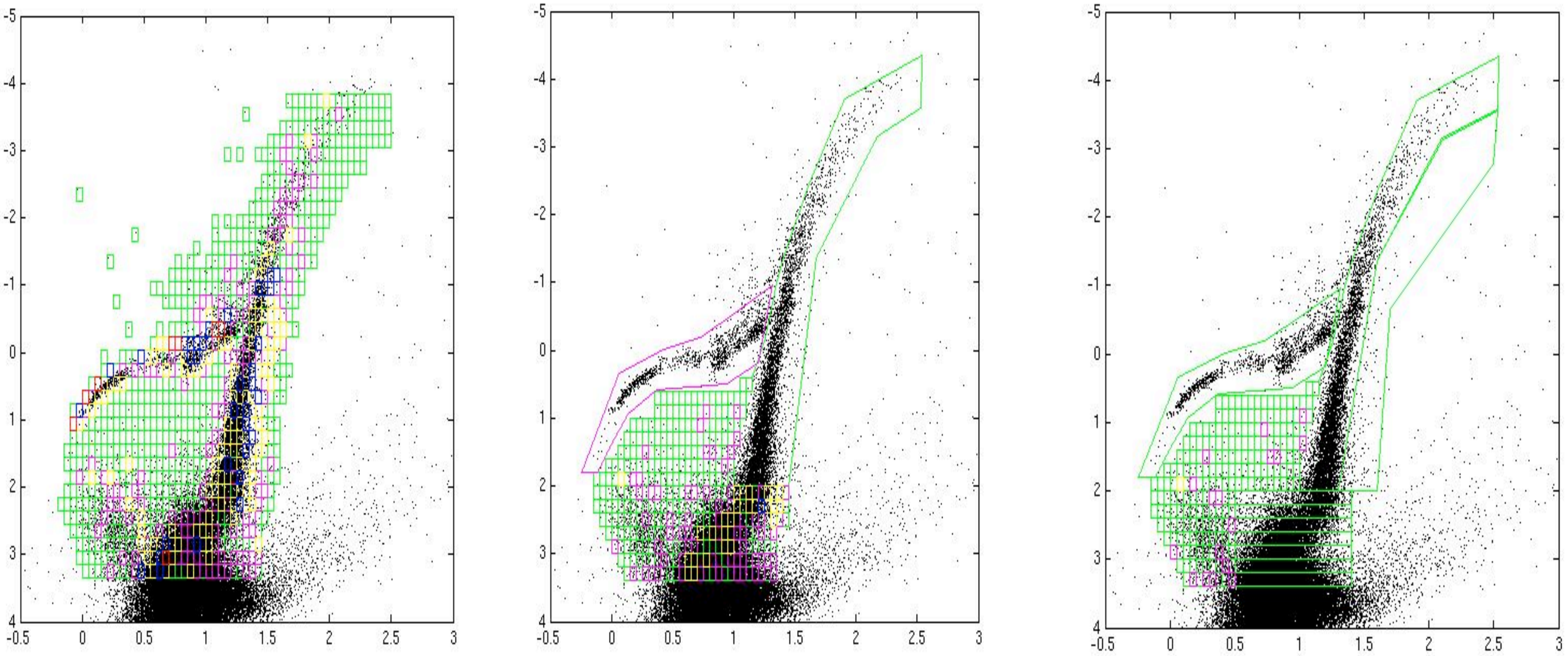


http://iac-star.iac.es



V. Parametrize the CMD and star count

How to choose a good parameterization?



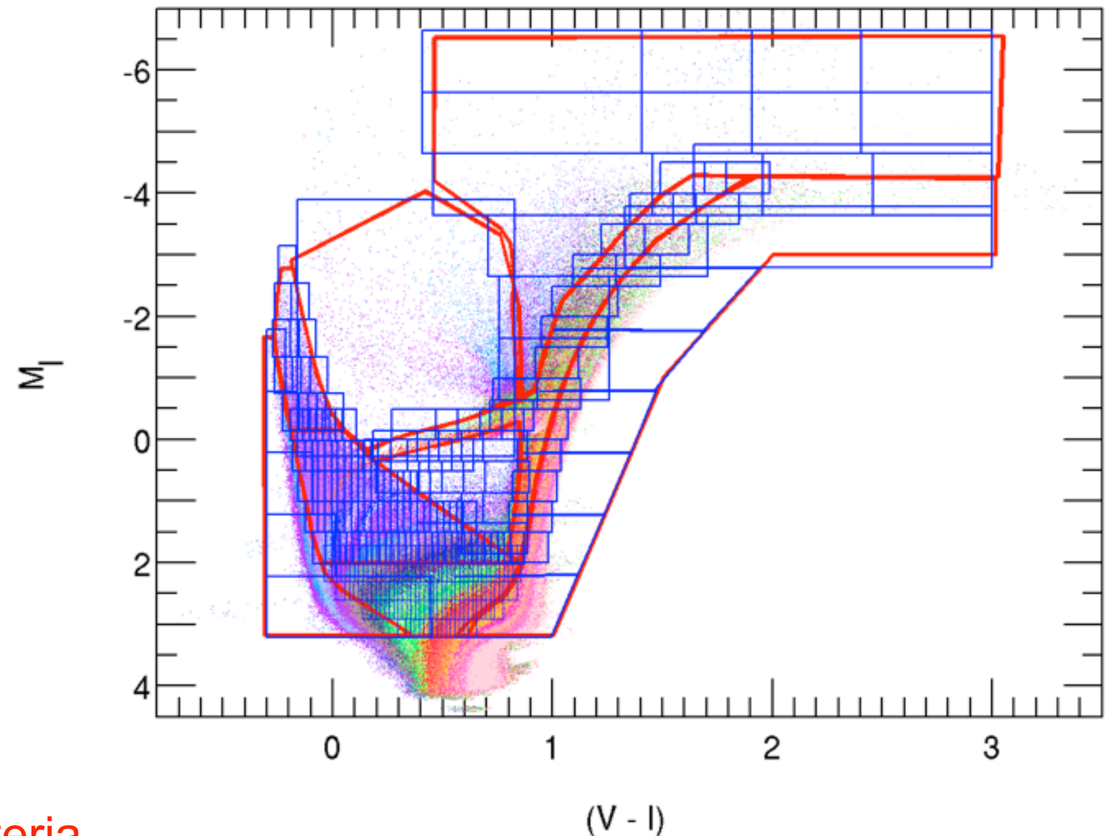
General criteria

*) some part of the CMD are more important than others → different sampling

*) avoid fluctuactions of individual solutions → average of many

V. Parametrize the CMD and star count

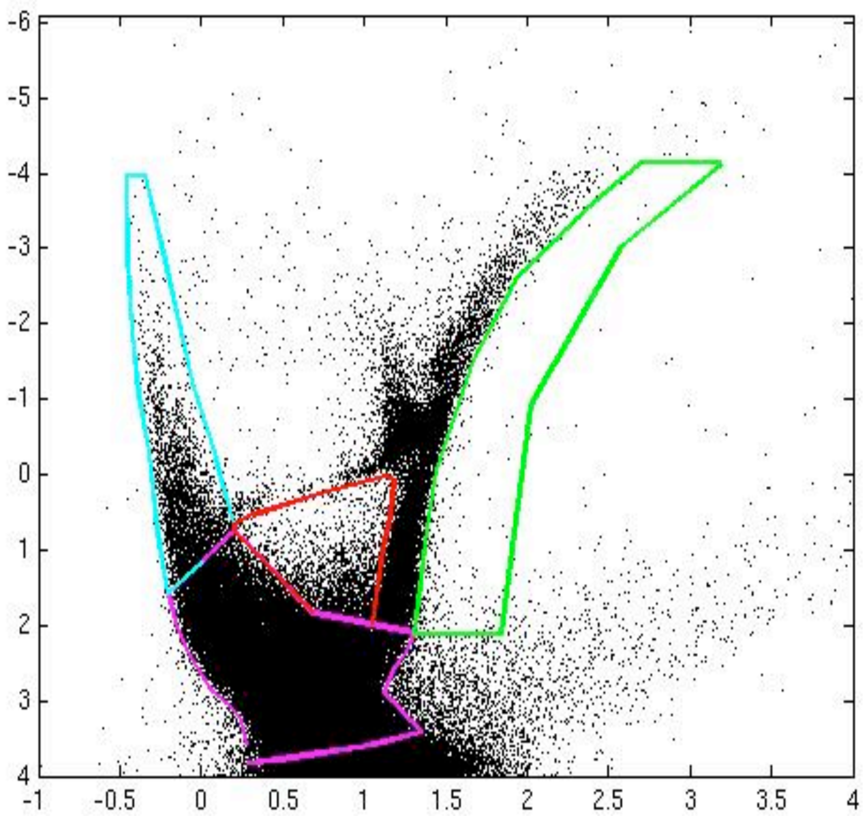
How to choose a good parameterization?



General criteria

*) some part of the CMD are more important than others → different sampling

*) avoid fluctuactions of individual solutions → average of many



MINNIAC

I) We introduced the concept of *bundle*:

Each bundle is sampled with boxes of different sizes: the smallest boxes where the physics is best known, and the models are more accurate: on the MS and TO regions;

N.B. We ONLY use the MS and subgiant: NO RGB!

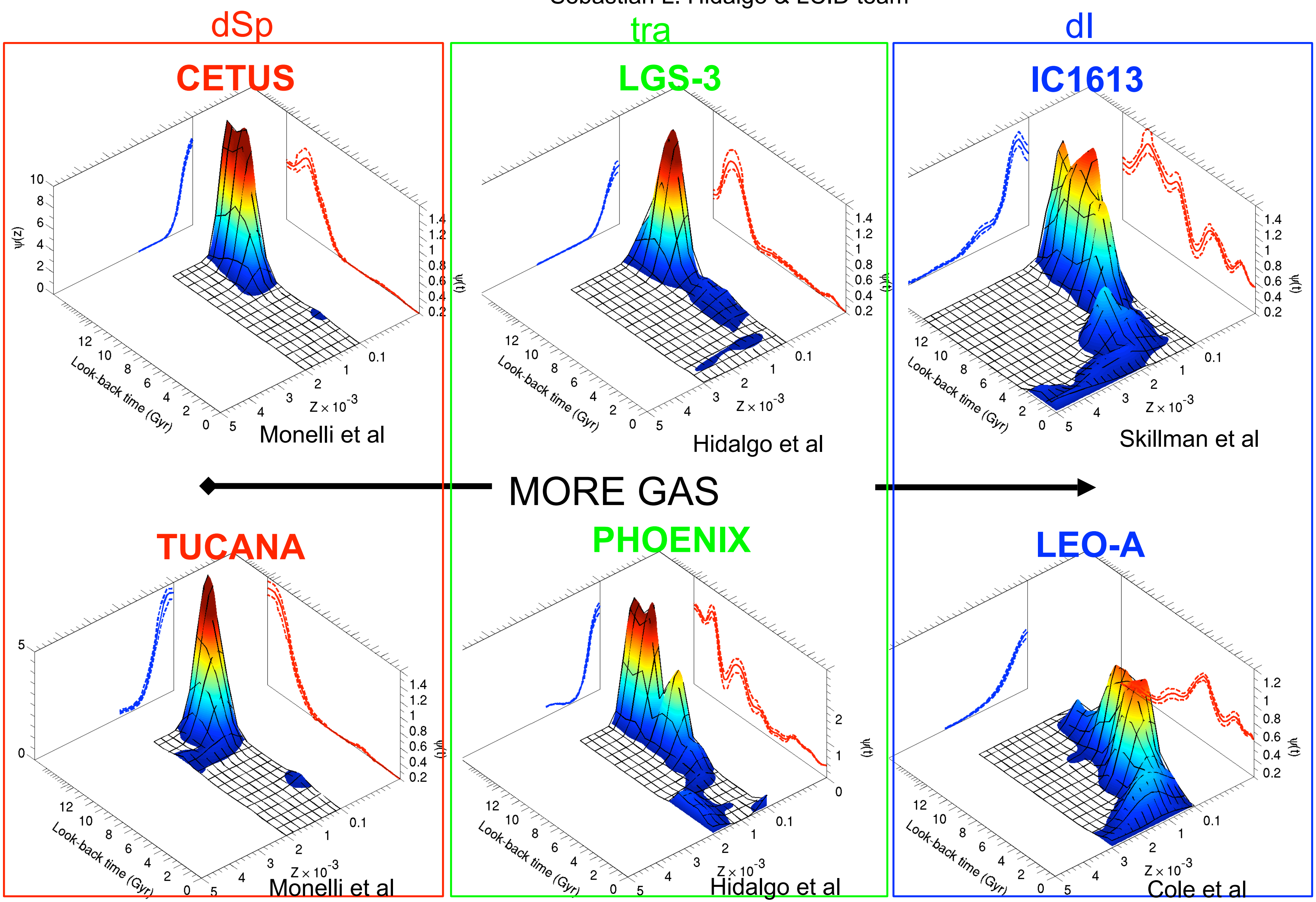
a model CMD +
a set of bundles and boxes +
a set of simple populations

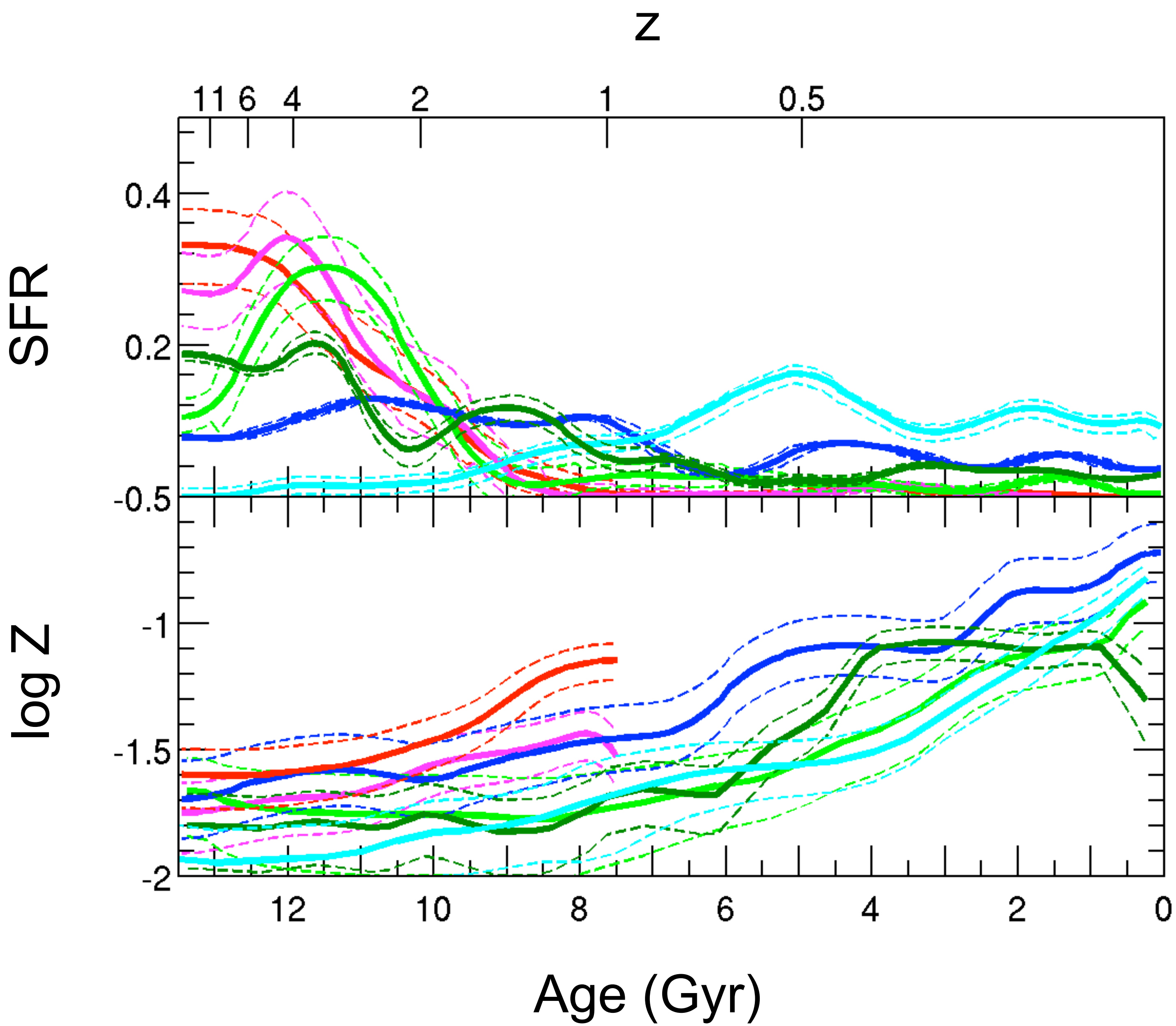
→ ONE solution

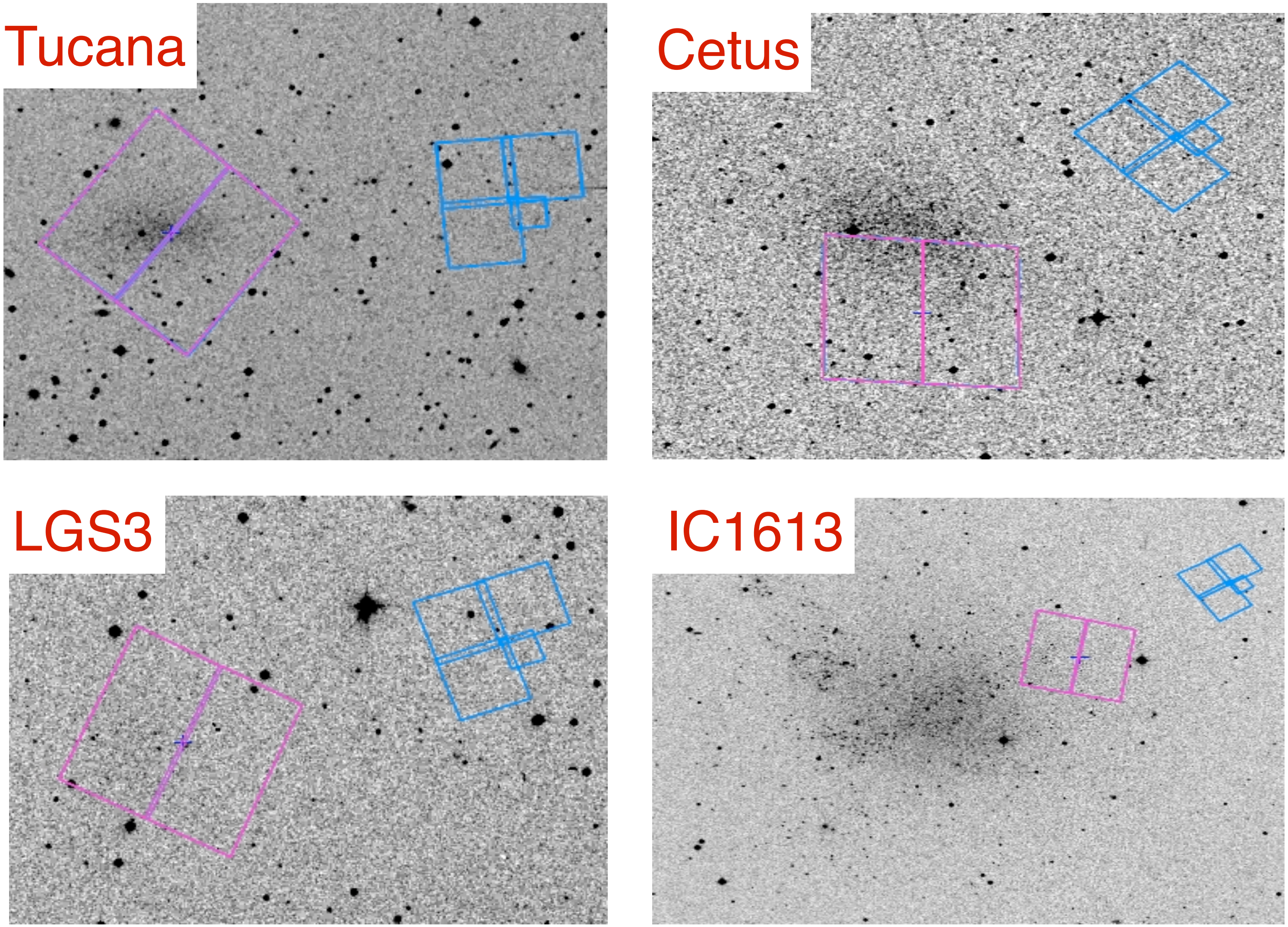
Results

The LCID project
Local Cosmology from Isolated Dwarfs

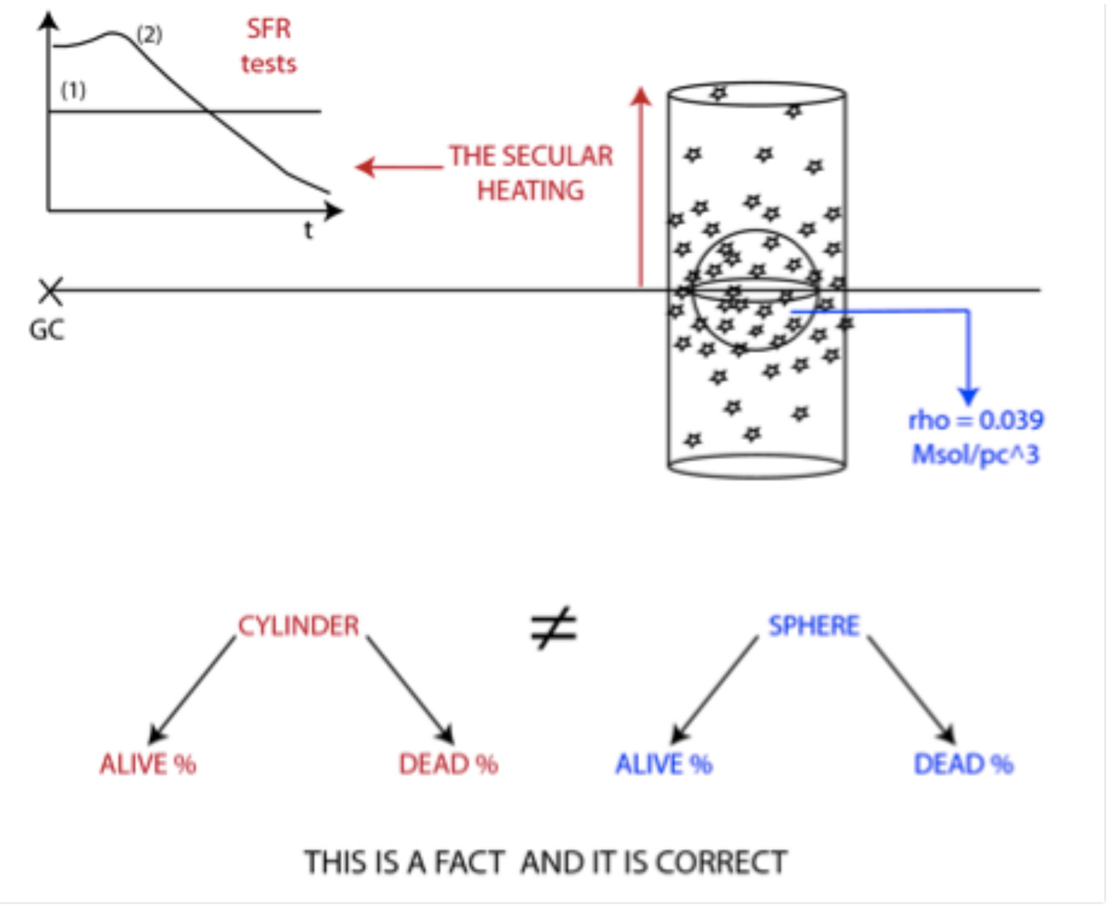
Sebastian L. Hidalgo & LCID team



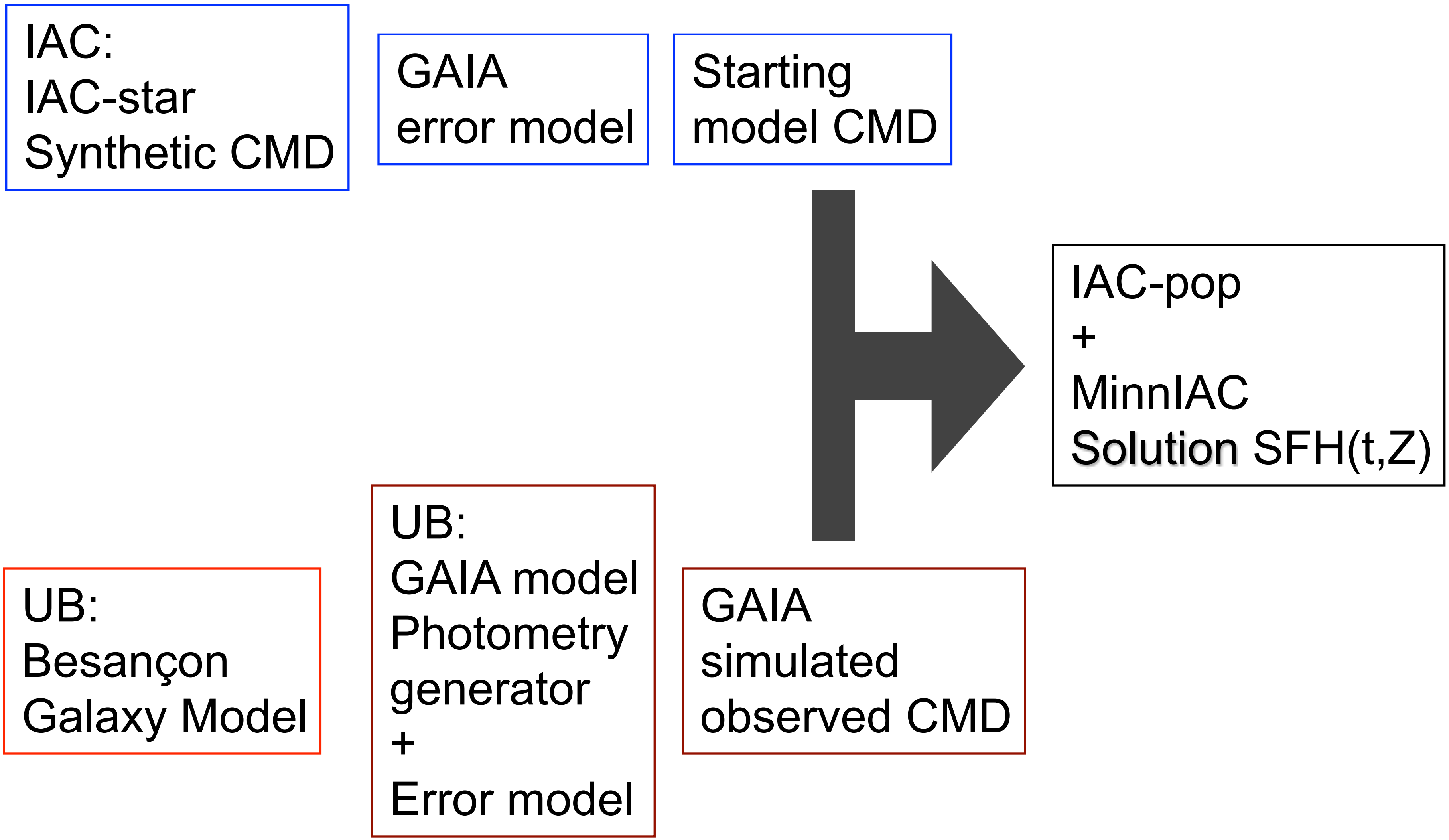

z
11
1
6
4
2
1
0.5
SFR
0.4
0.2
-0.5
log Z
-1
-1.5
-2
12
10
8
6
4
2
0
Age (Gyr)

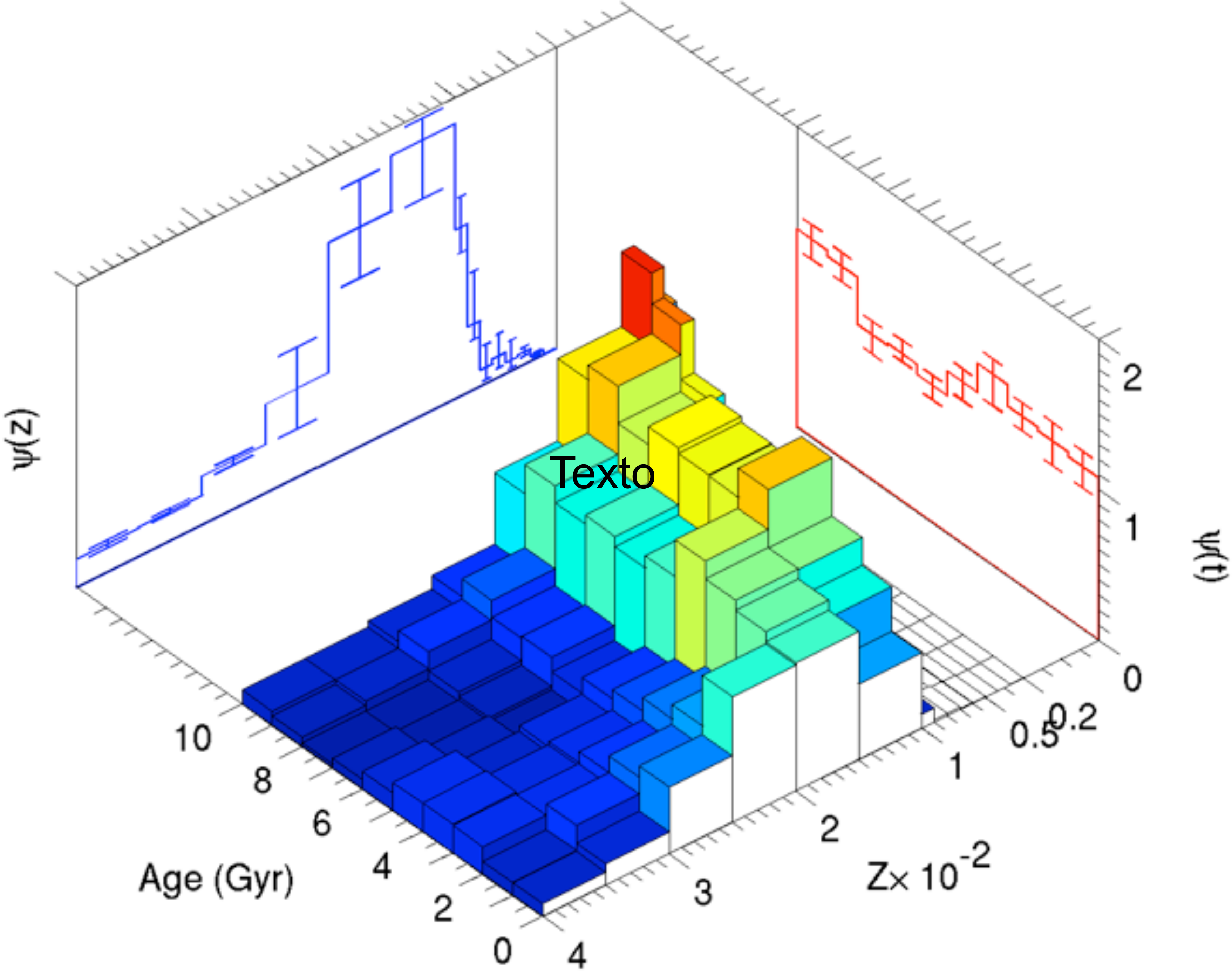

Tucana
Cetus
LGS3
IC1613

Model: Besançon Milky Way Disk
Cilinder centered on the Sun with r=100pc
Age: 0-10 Gyr - constant SFR
Metalicity: solar with gaussian dispersion
Binaries: no

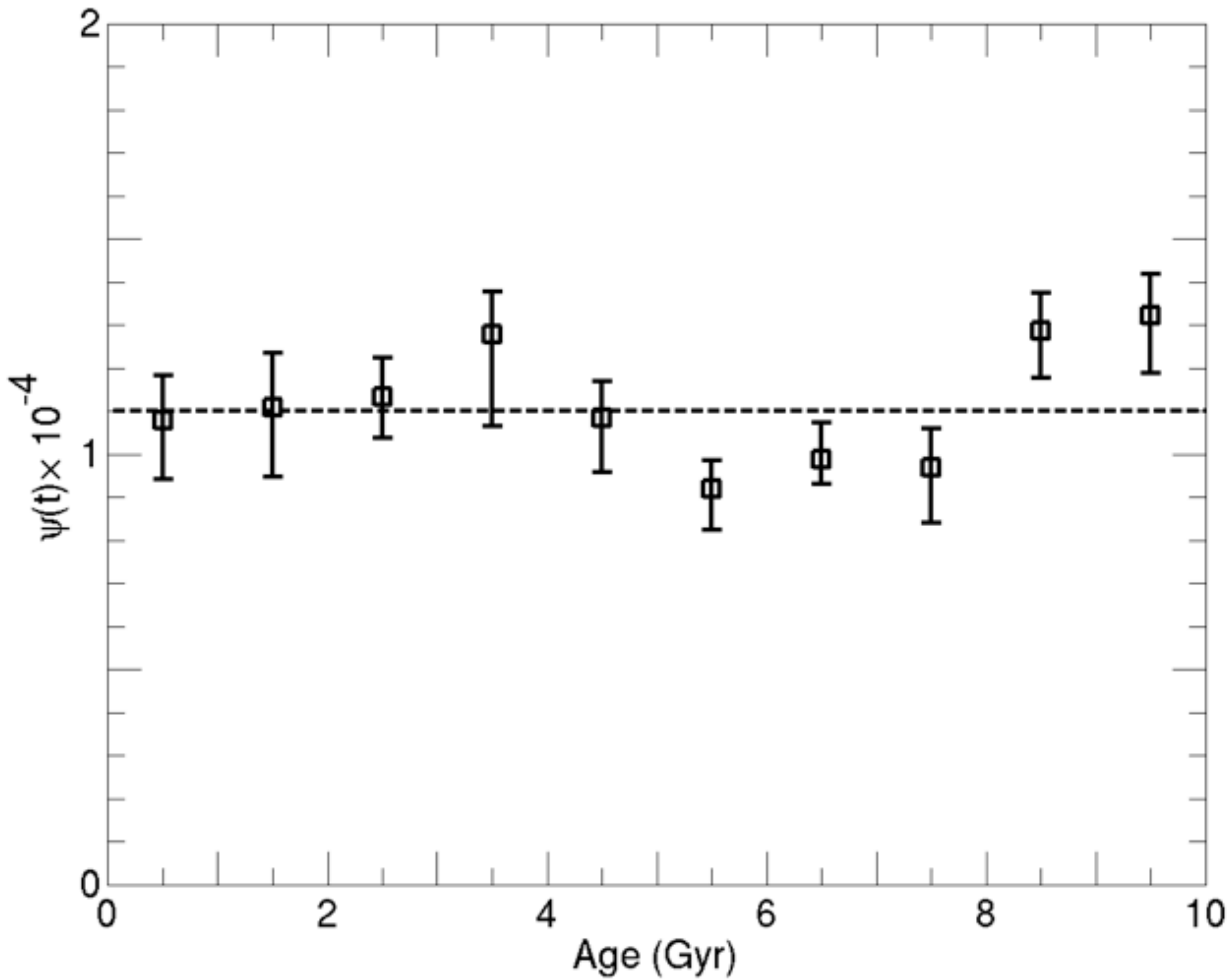


Test summary

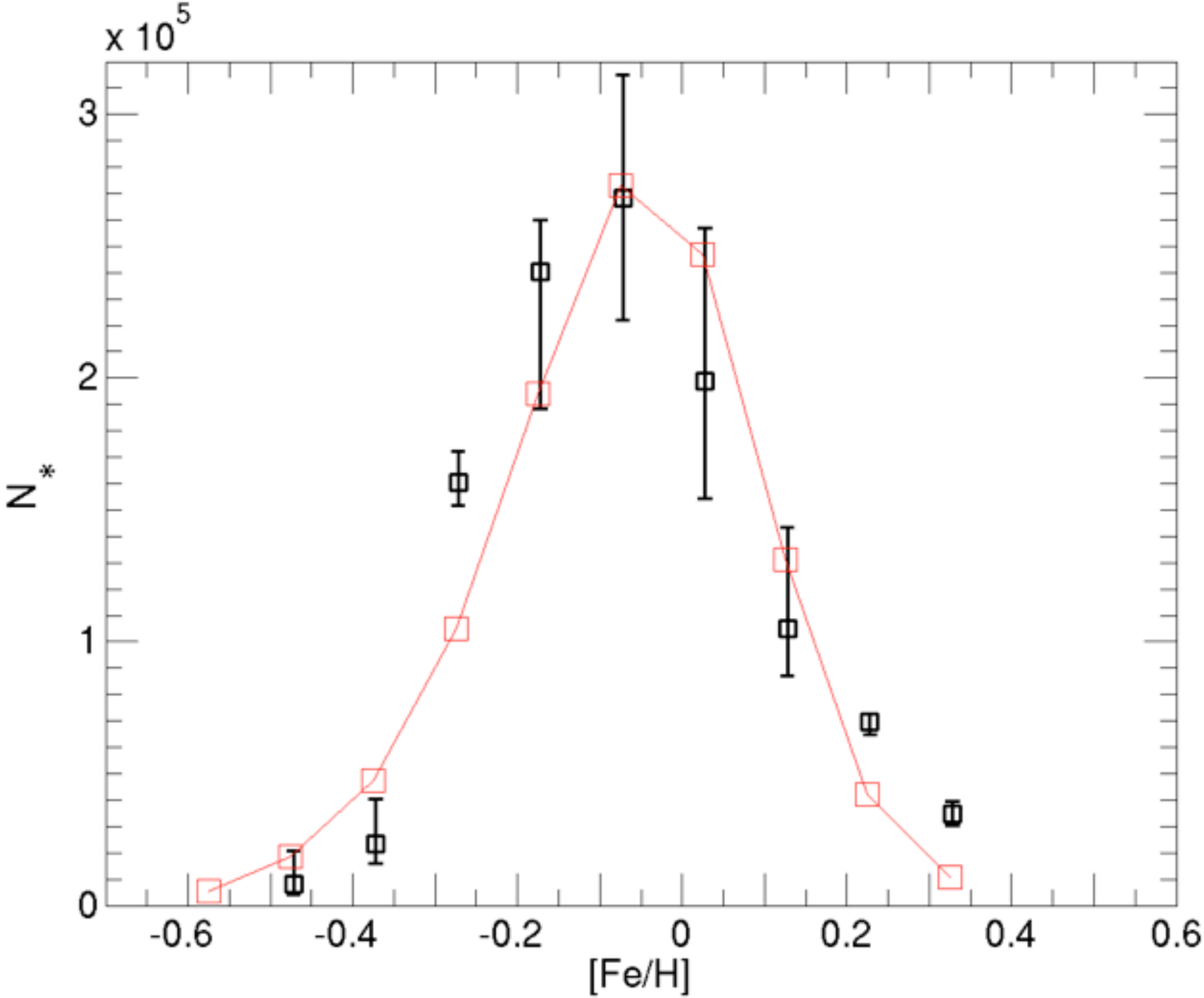




ψ(z)
Texto
ψ(t)
Age (Gyr)
10
8
6
4
2
0
4
3
2
1
0.5
0.2
Z× 10^-2
0
1
2



2
1
0
0
2
4
6
8
10
Age (Gyr)
ψ(t)× 10^-4



x 10^5
3
2
1
0
N*
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
[Fe/H]