Opticon ELT science meeting

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Science case for a 50-100m ELT: playing with stellar clusters

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with the contribution of the **Bologna Group of Stellar Populations**

stellar clusters: properties

- **simple stellar populations**
  aggregate of stars coeval & initially chemically homogeneous
- **ideal laboratories to test stellar evolution → clock, IMF**
  populous enough in all the evolutionary sequences
- **ideal laboratories to test chemical evolution → ISM enrichment**
  primordial enrichment *vs* stellar nucleosyntesis
- **ideal laboratories to test stellar interactions → stellar dynamics**
  mass segregation, cannibalism, tidal stripping, *etc.*
- **important channel of star formation**
  a significant fraction of stars form[ed] in stellar clusters
- **important tracers of galaxy assembly**
  formation of stellar cluster systems: *in situ vs* accretion *vs* merging scenarios

⇨ **fundamental tracers of galaxy formation & evolution**

stellar clusters: evolutionary features

- **Tip RGB** → **standard candle**
- **MS-TO** → **age** = **f** (L_{TO} , Y, Z)
  (L_{TO} ↓ distance)
- **MS-cutoff** → **IMF, test of SE models @ low-mass end**
- **WD cooling sequence** → **age, distance, test of SE models**

stellar clusters: resolving their SPs

- **crowding** → $\langle d \rangle = 1/(\pi\langle\rho\rangle)$ = average projected distance among stars at different mag levels & radial distances

8m → 1.22 λ/D = 31.46 [mas] λ [μm]

30m → 1.22 λ/D = 8.39 [mas] λ [μm]

50m → 1.22 λ/D = 5.03 [mas] λ [μm]

100m → 1.22 λ/D = 2.52 [mas] λ [μm]

- **confusion** → $m_{lim}(\lambda, D) \approx m_{BG} + 1.2$

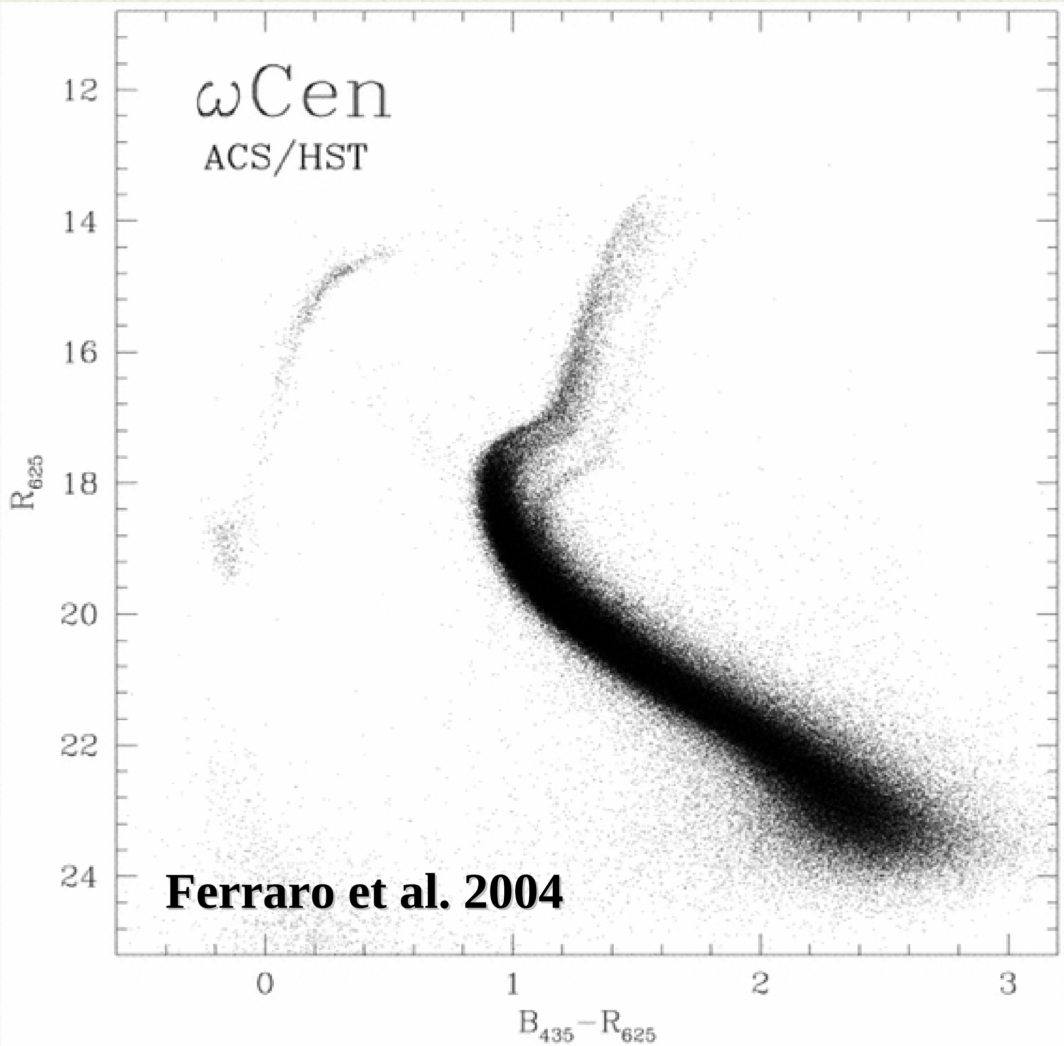
$$\Delta m_{lim} = -5 \log10 D_1/D_2$$

8m *vs* 100m → = 5.5

30m *vs* 100m → = 2.6

50m *vs* 100m → = 1.5

old globular clusters: resolving their SPs



ω Cen

$(m-M)_V = 14$ d = 5 kpc

crowding $\rightarrow \langle d \rangle = 1/(\pi\langle\rho\rangle)$

$\langle d \rangle_{int}$ = 5"–10" → 0.1–0.2 pc
R=2'–6' V≤ 16 (RGB & HB)

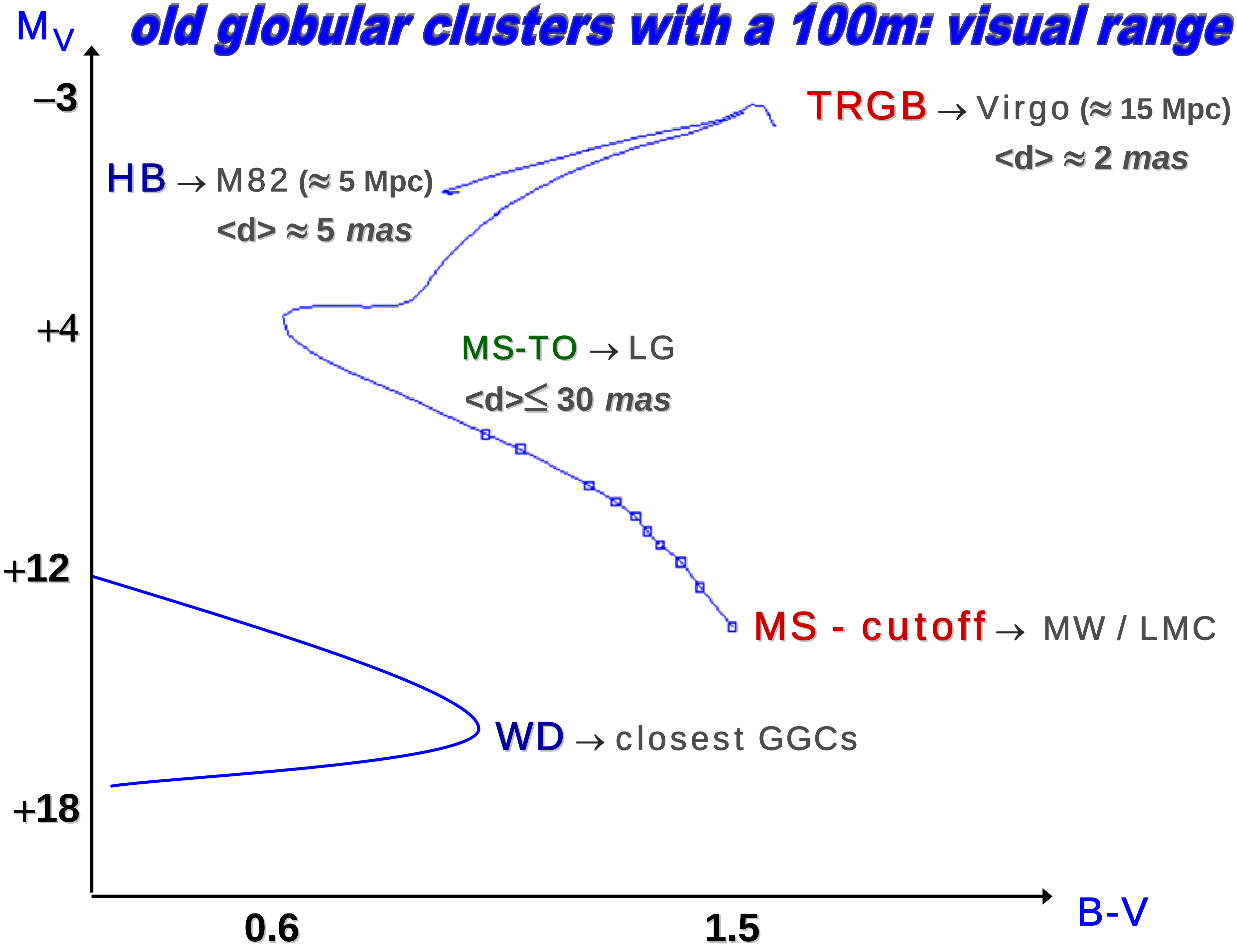
$\langle d \rangle_{int}$ = 0.2"–1" → 0.01–0.02 pc
R=2'–6' V≤ 23 (TO & below)

$\langle d \rangle_{ext} \approx 10 \times \langle d \rangle_{int}$

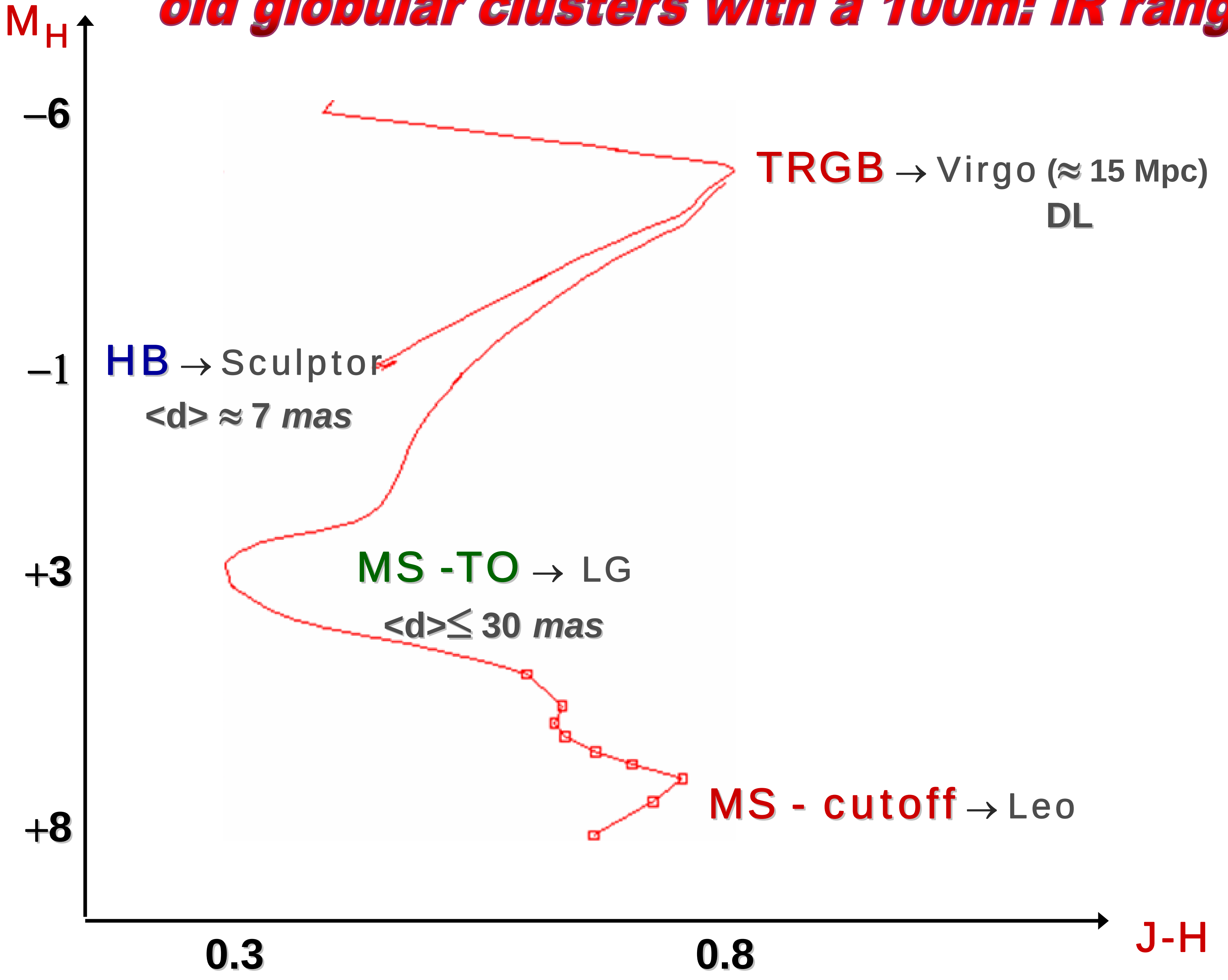
confusion → $V_{lim} \approx 28 \longrightarrow 33$
$H_{lim} \approx 26 \longrightarrow 31$

see also Table 4 ELT- Stars & Galaxies '01

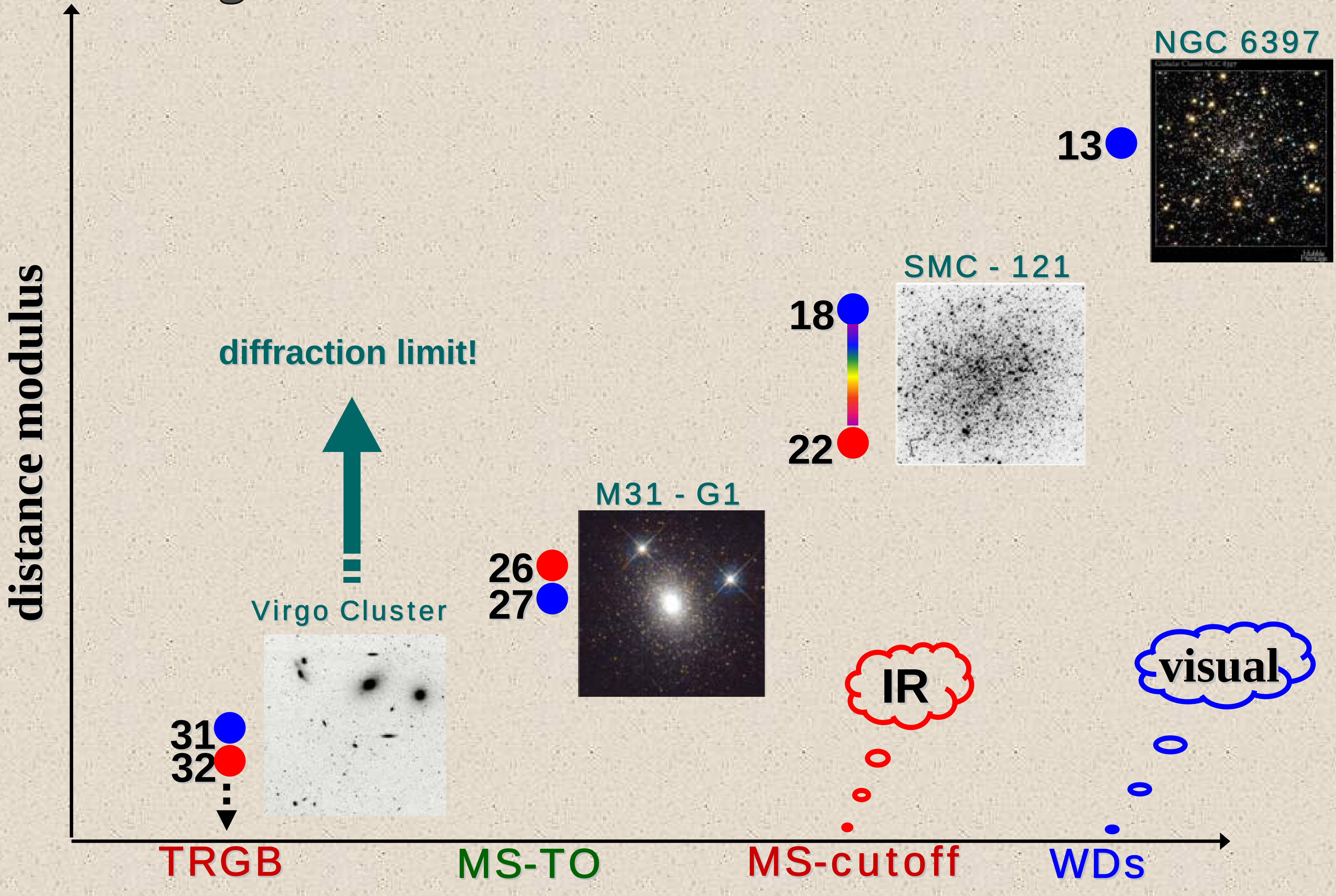
old globular clusters with a 100m: visual range



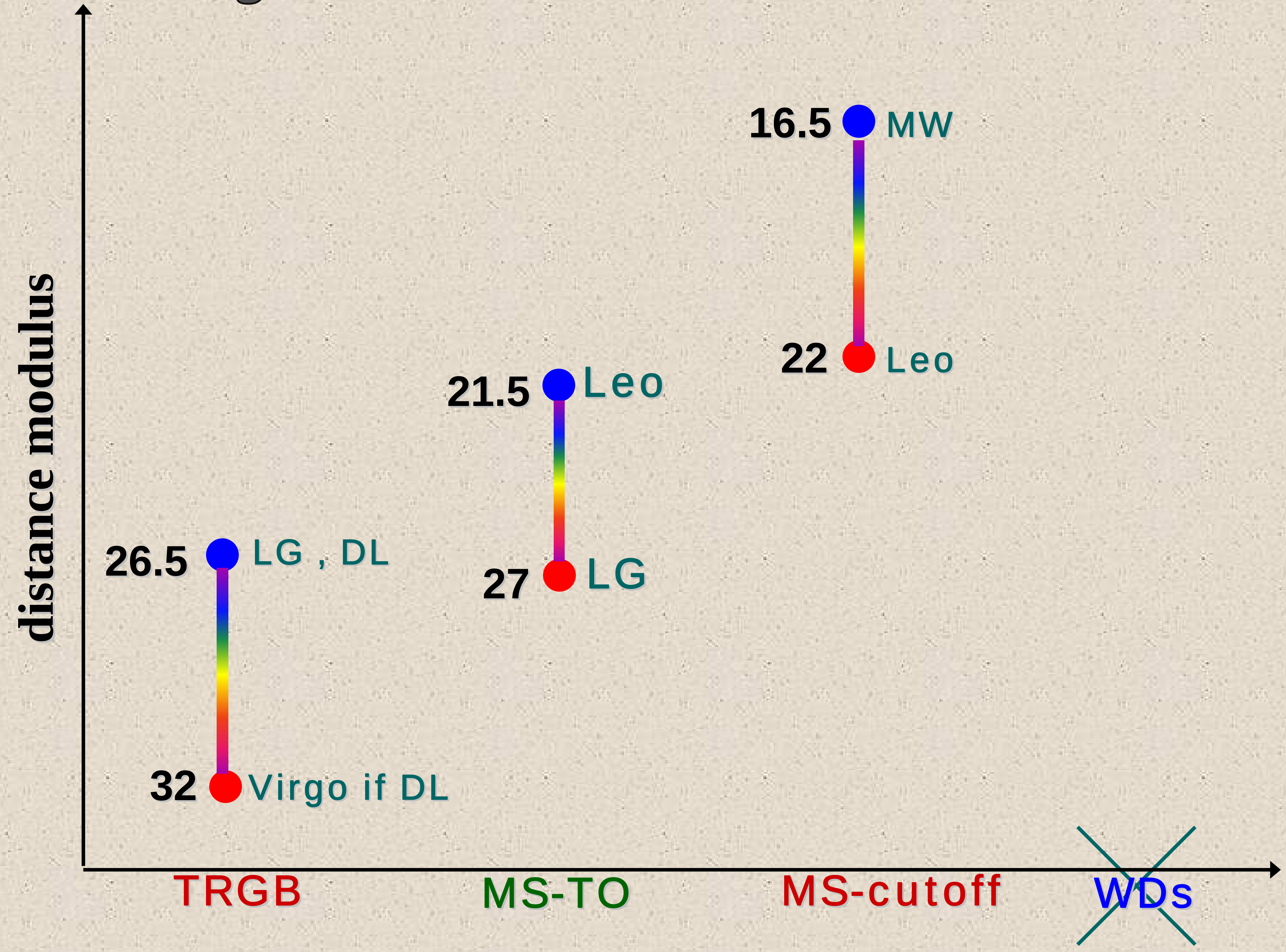
old globular clusters with a 100m: IR range



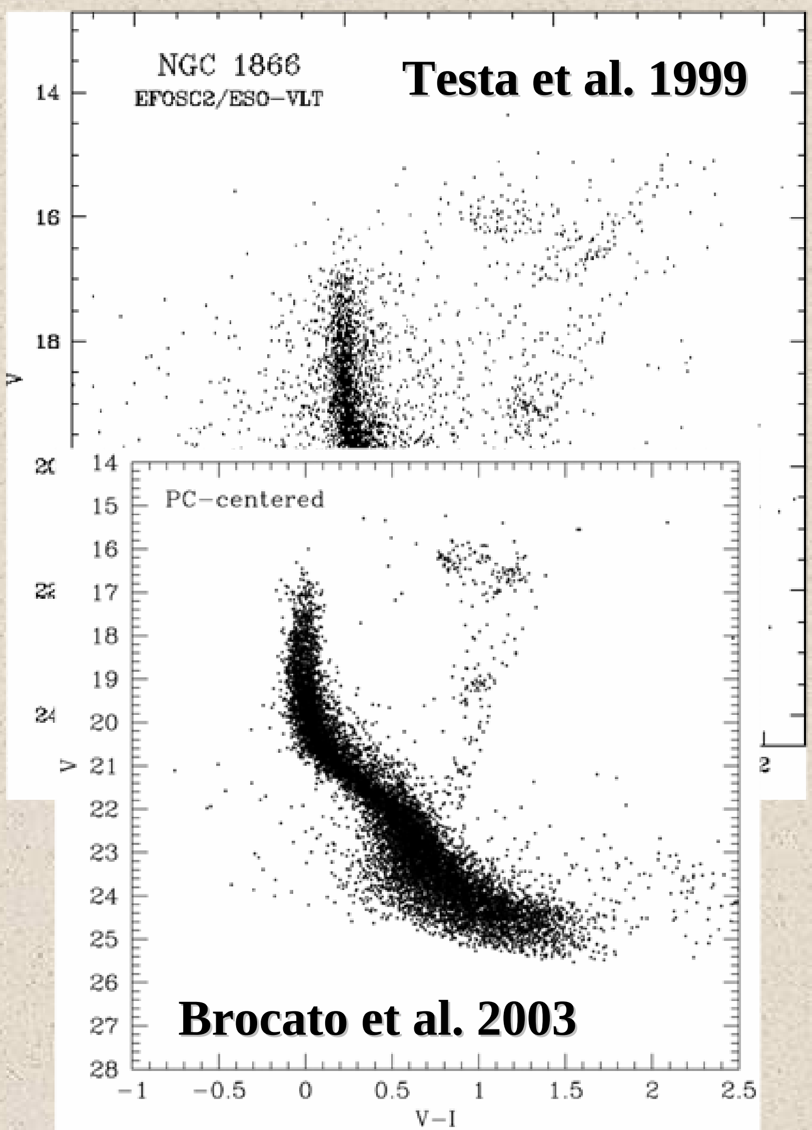
old globular clusters: visual vs IR



old globular clusters: JWST vs 100m



young globular clusters: resolving their SPs



NGC 1866 – LMC

$(m-M)_V = 18.5$ $d = 50$ kpc

crowding $\rightarrow \langle d \rangle = 1/(\pi \langle \rho \rangle)$

$\langle d \rangle = 1'' - 1.5'' \rightarrow 0.2-0.4$ pc

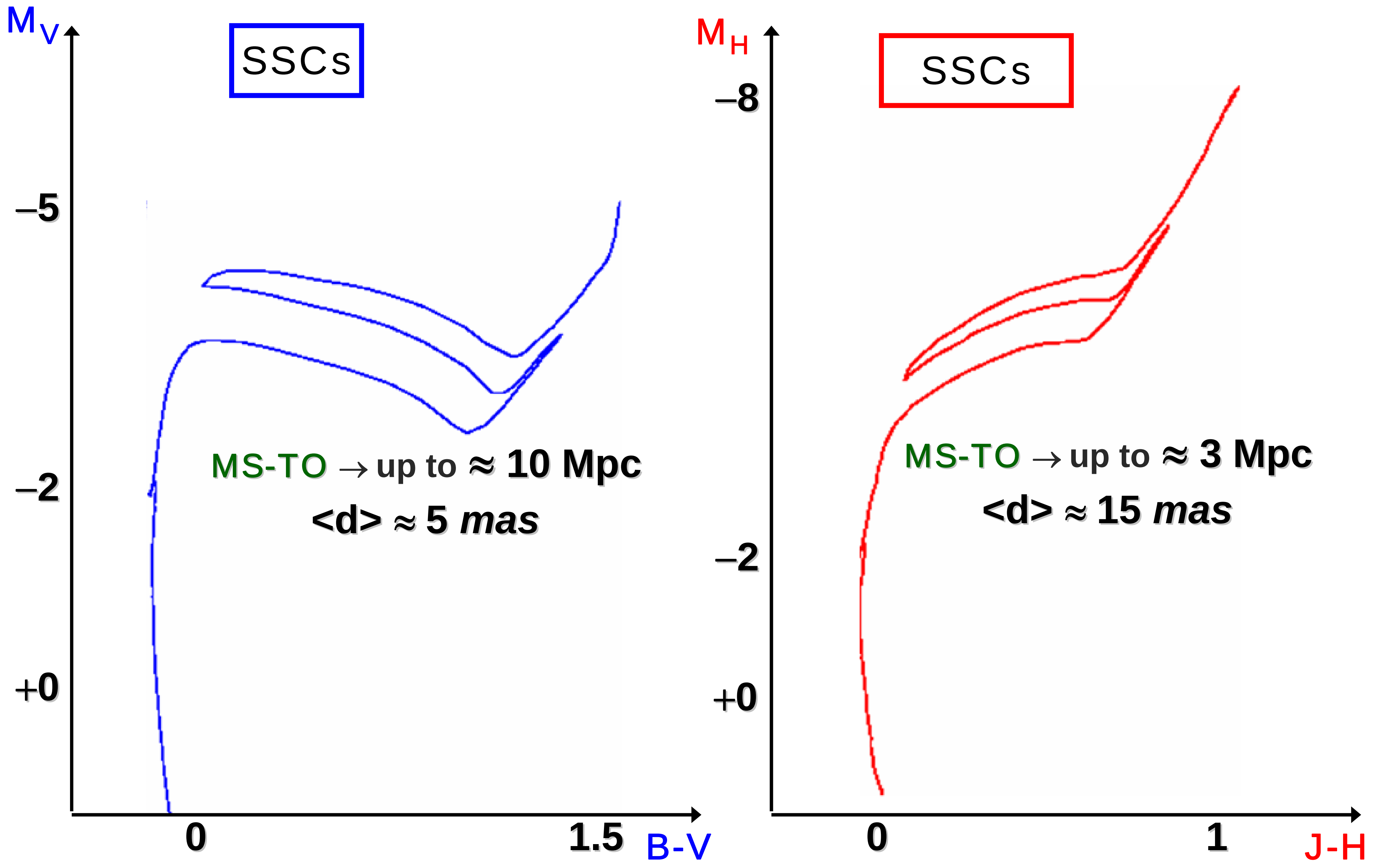
R=1'–2' $V \leq 23$

MS-TO at $M_V \approx -2$

confusion $\rightarrow V_{lim} \approx 30$

$H_{lim} \approx 27$

young clusters with a 100m: visual & IR ranges



stellar clusters: high resolution spectroscopy

- $R_\lambda = 30{,}000$, S/N = 30 → kinematics, abundances

ELT ETC → 30% encircled energy , RON = $1e^{-}$/px
px scale = 1 mas/px , slit width = 3 mas

$T_{eff} = 5000K$ $V = 25$, $T_{eff} = 3800K$ $H = 22$ → $t_{exp} = 4hr$

$M_V = 0$ $(m\text{-}M) = 25$, $M_H = -5$ $(m\text{-}M) = 27$ → LG

integrated light:

$M_V = -7$ $(m\text{-}M) = 32$, $M_H = -11$ $(m\text{-}M) = 33$ → Virgo

stellar clusters: multi-wavelength approach

- each sequence in the most suitable range

  hot in the UV-optical, cool in the IR

- each environment in the most suitable range

  metal poor, low reddening (e.g. halos) in the UV-optical
  metal rich, high reddening (e.g bulges) in the IR

- larger baseline → better definition of stellar & population parameters

  temperature, gravity, metallicity, mass, IMF, reddening etc.

  nebular *vs* stellar contributions, mass loss, SF rates etc.