The nearest stars and BDs in *Gaia* DR2 and EDR3

Image credit:
ESA/Gaia

AIP

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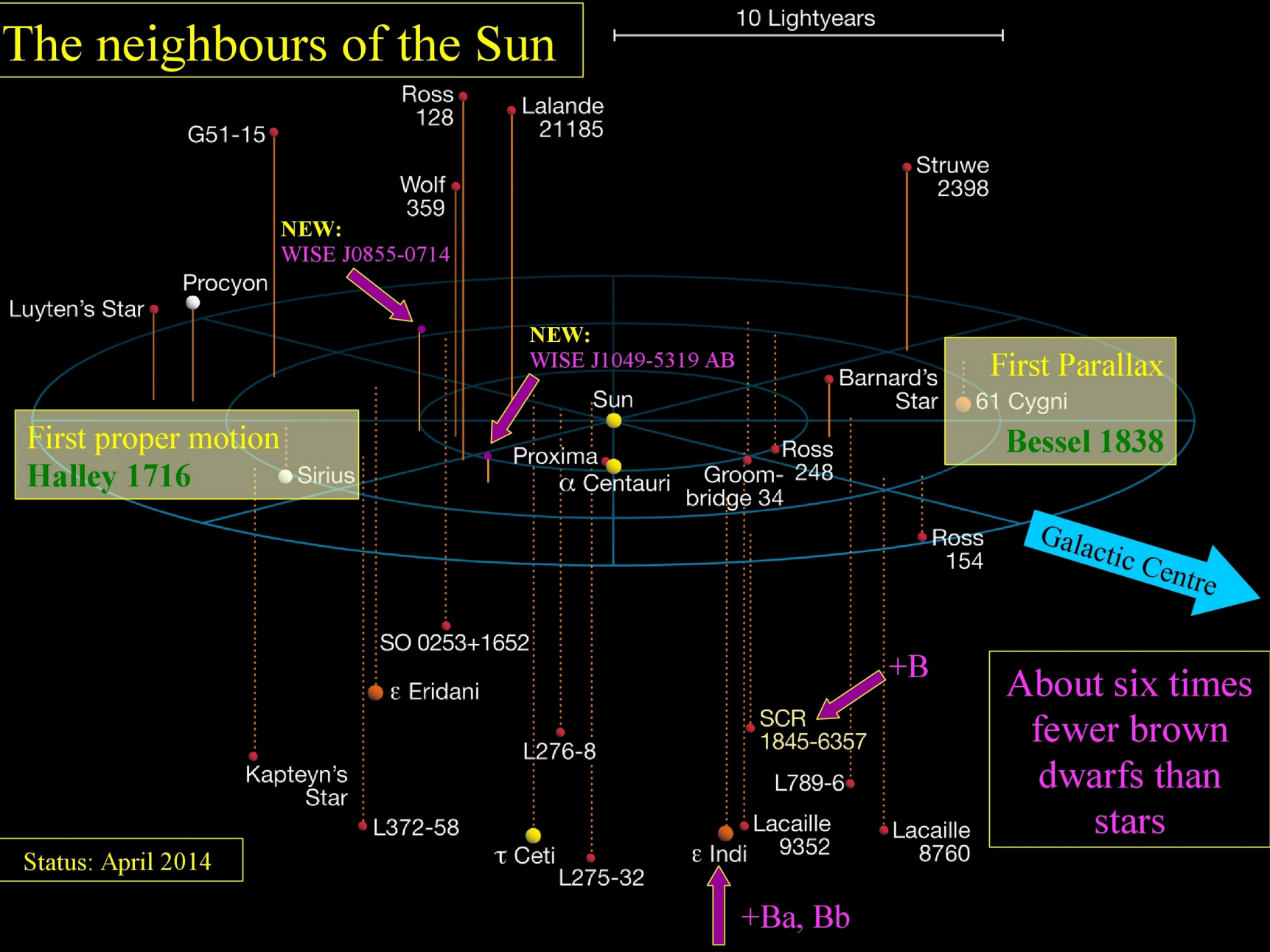
Milky Way and the Local Volume

The neighbours of the Sun



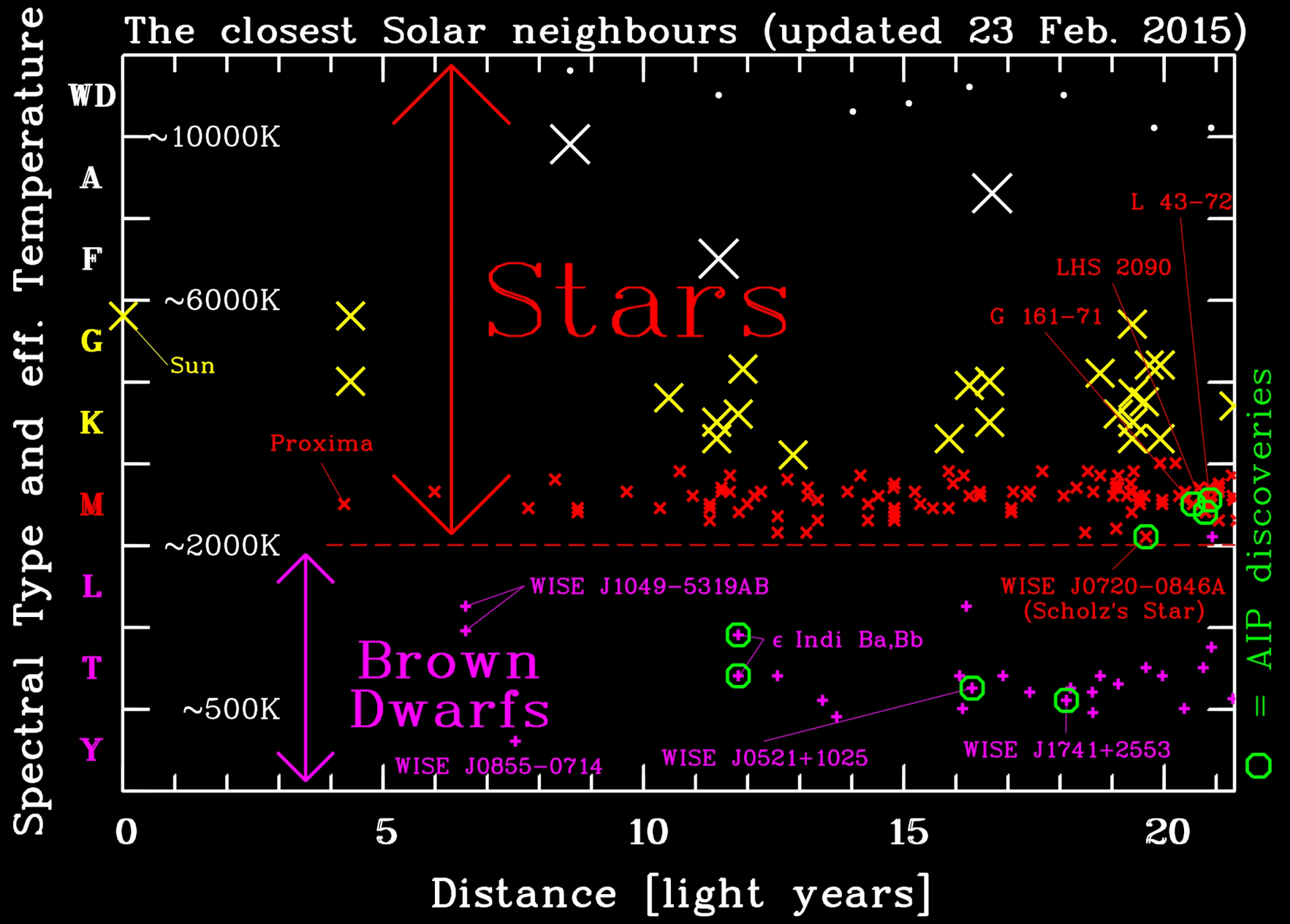
≈3.8 pc sample

(12.5 light years)

Image credit:
Ralf-Dieter Scholz, AIP / Richard Powell, atlasoftheuniverse.com

About six times fewer brown dwarfs than stars

→ **in agreement with**
Henry et al. (2019)
Kirkpatrick et al. (2019)



≈6.5 pc sample

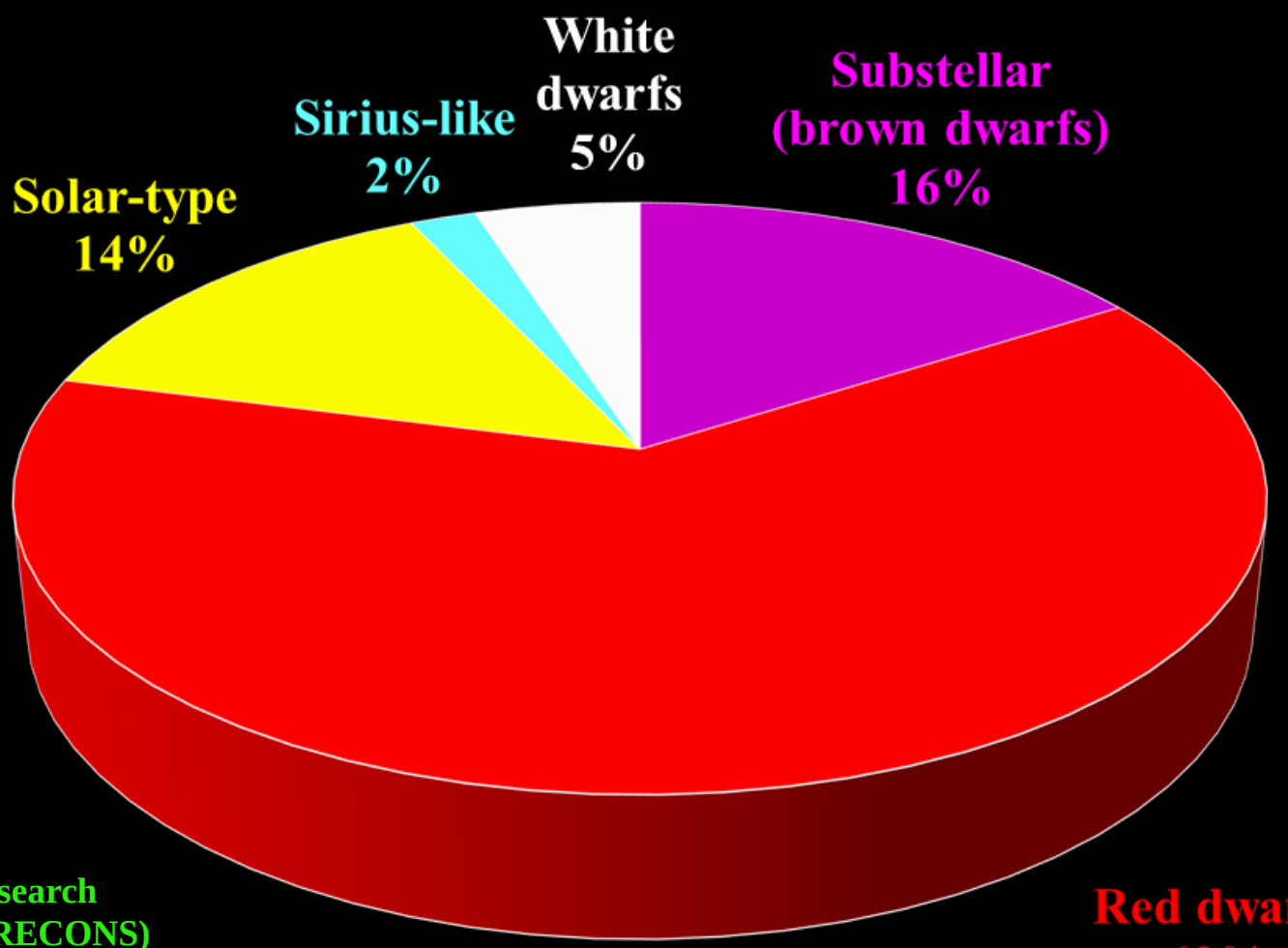
Knowledge on M + LTY since use of:

photographic astrometry ≈100 yr ago

Infrared-astronomy ≈25 yr ago

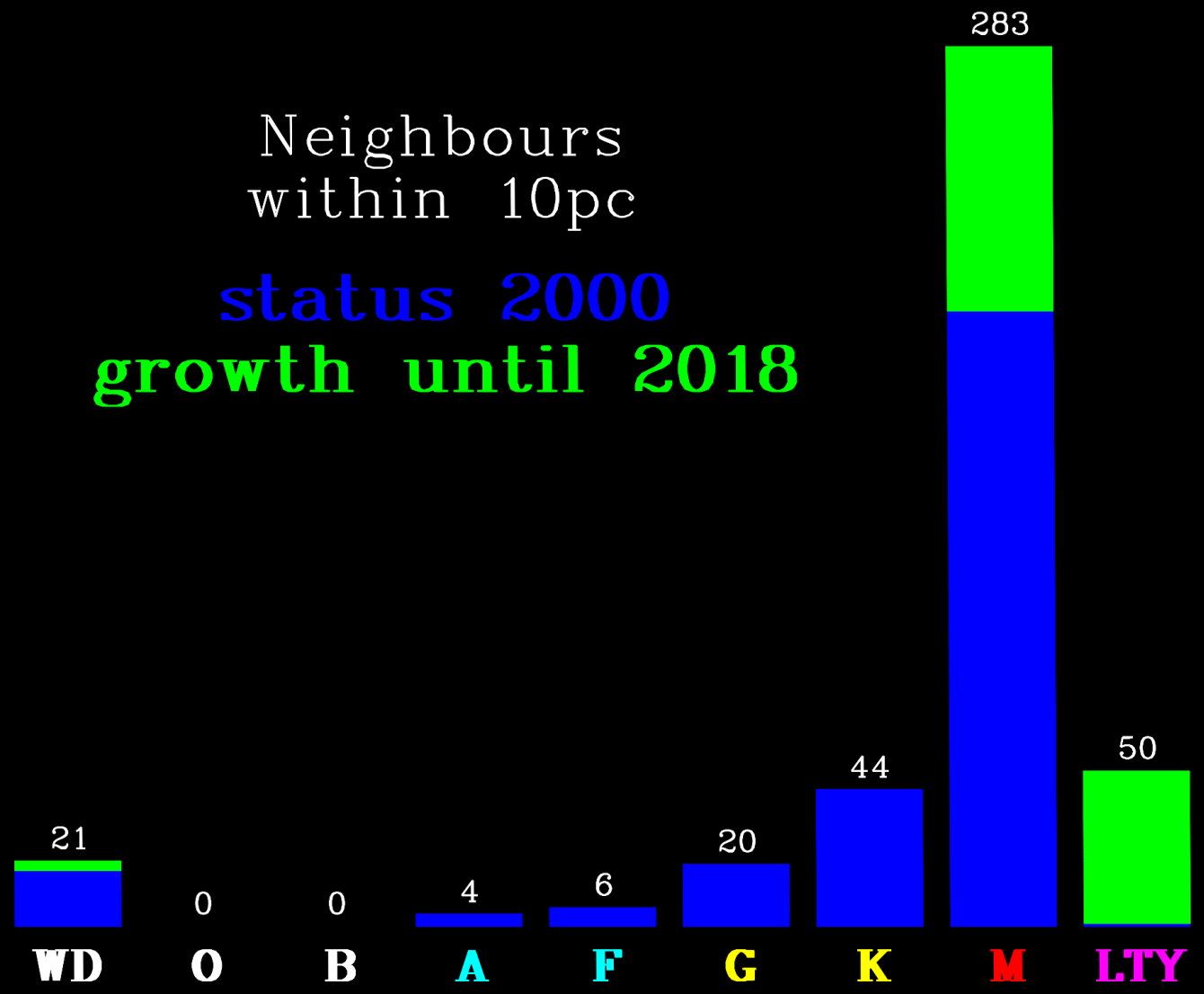
Image credit:
Ralf-Dieter Scholz, AIP

Stellar and substellar fractions in the Solar neighbourhood (d < 6.5 pc)



based on the TOP100 of the REsearch Consortium On Nearby Stars (RECONS) and Bihain & Scholz (2016)

Progress for 10 pc sample achieved before *Gaia* DR2

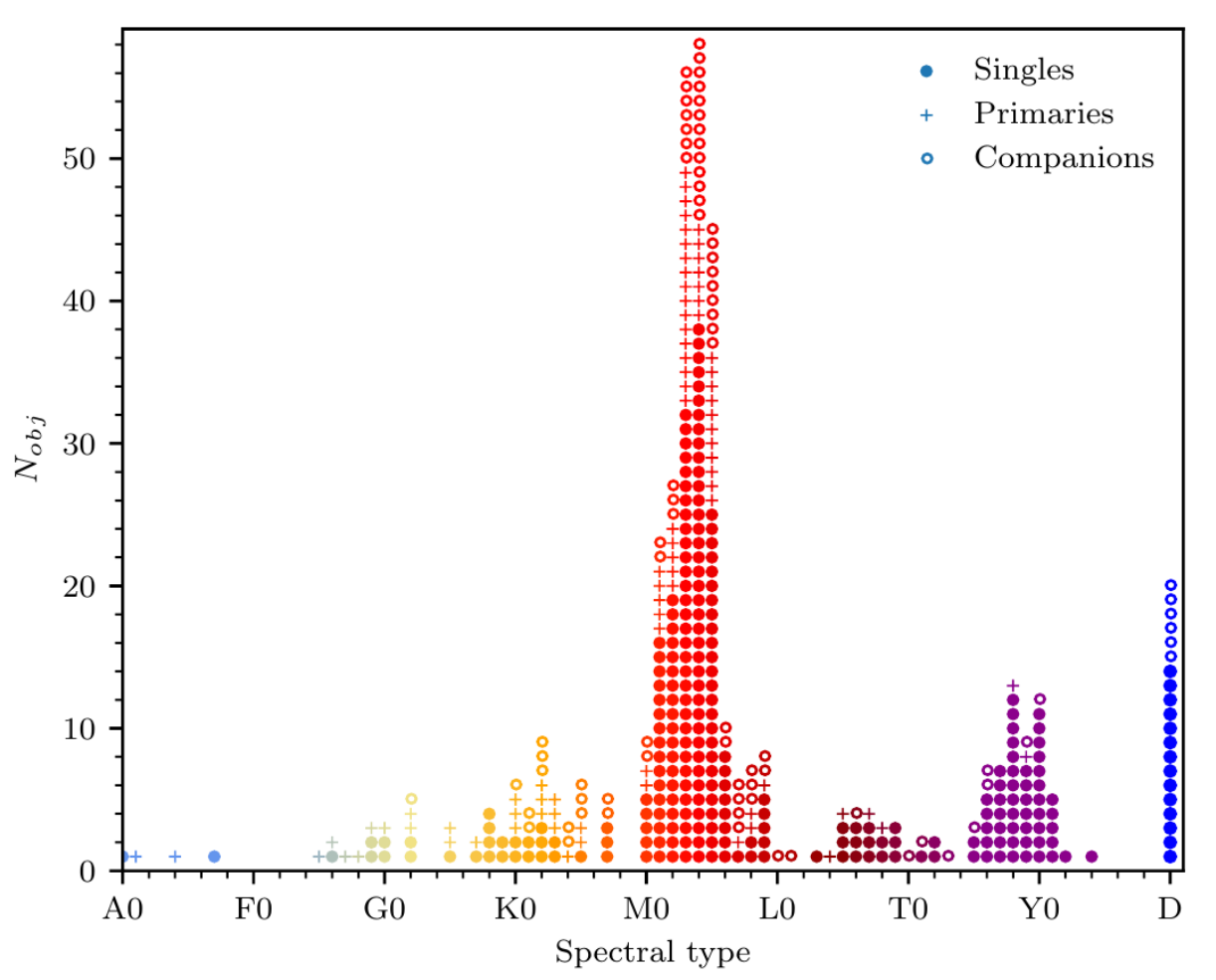


Successful search for and confirmation of new neighbours by many different surveys and parallax programs !

Henry et al. (2018):
- history + RECONS part
- 90% stellar completeness

Pre-*Gaia* census:
428 objects in 317 systems, based on statistics from RECONS (March 2018)

„The 10 pc sample in the *Gaia* era“ (Reyle et al. 2021)



RECONS did not publish 10 pc sample (only statistics)

Reyle et al. (2021) provide the first list of all known stars and **brown dwarfs (BDs)**, as well as exoplanets, within 10 pc

New catalogue was created from SIMBAD + **BDs** (mainly from **Kirkpatrick et al. 2021**) + combined with *Gaia* EDR3

smaller fraction of **M dwarfs (61%)** because of growing fraction of **BDs (19%)**

312 (67%) have parallaxes in *Gaia* EDR3

4	8	18	38	249	22	45	19	20	41 N/A	New census: 464 (stars and BDs)
(0)	(-1)	(-1)	(-6)	(-34)	(	+36	)	(-1)	(+41)	(Change with respect to RECONS)

Known nearby objects (d<10pc) not measured in *Gaia* EDR3

(Reyle et al. 2021)

Problematic cases:

- **8 stars that are too bright**
- **54 BDs that are probably too faint**
- **90 objects in close binary systems without full astrometric solution**

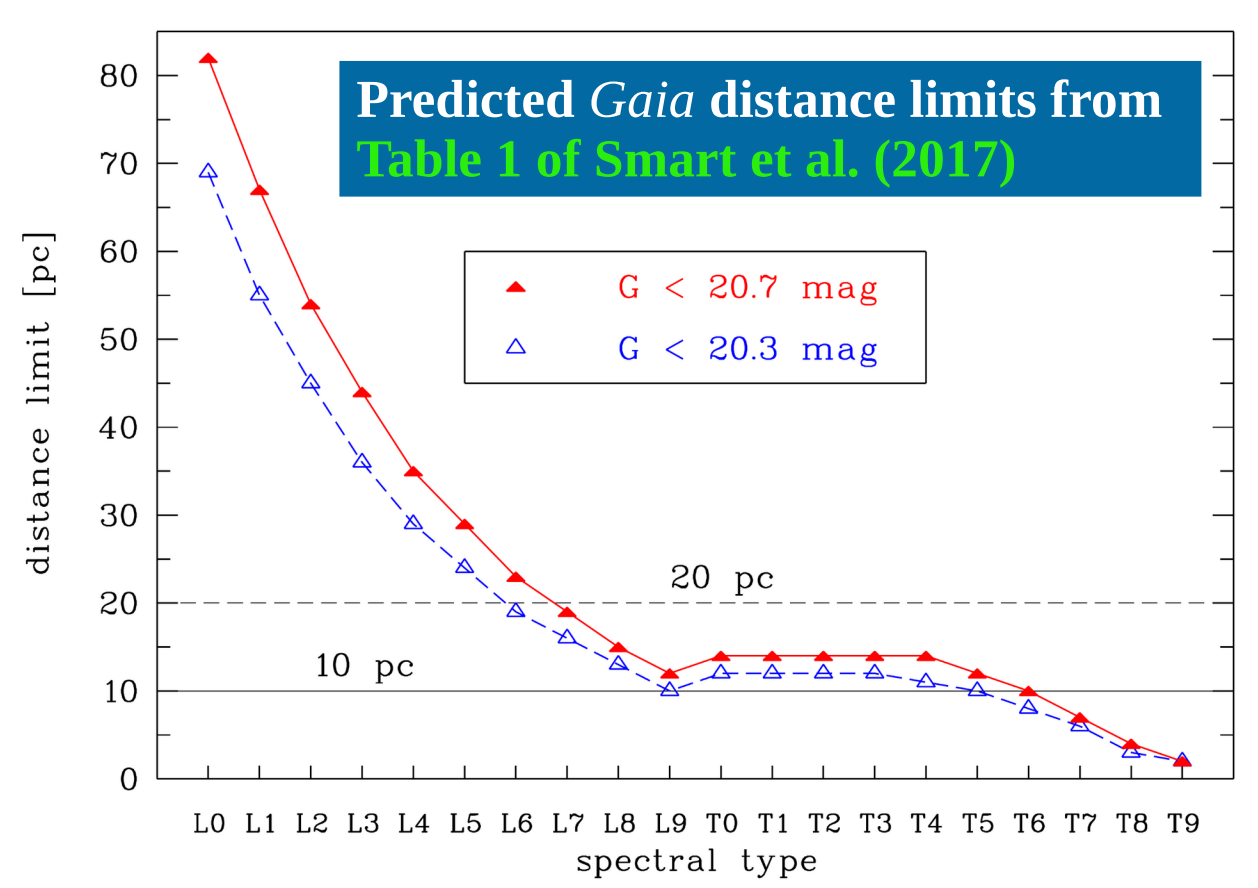
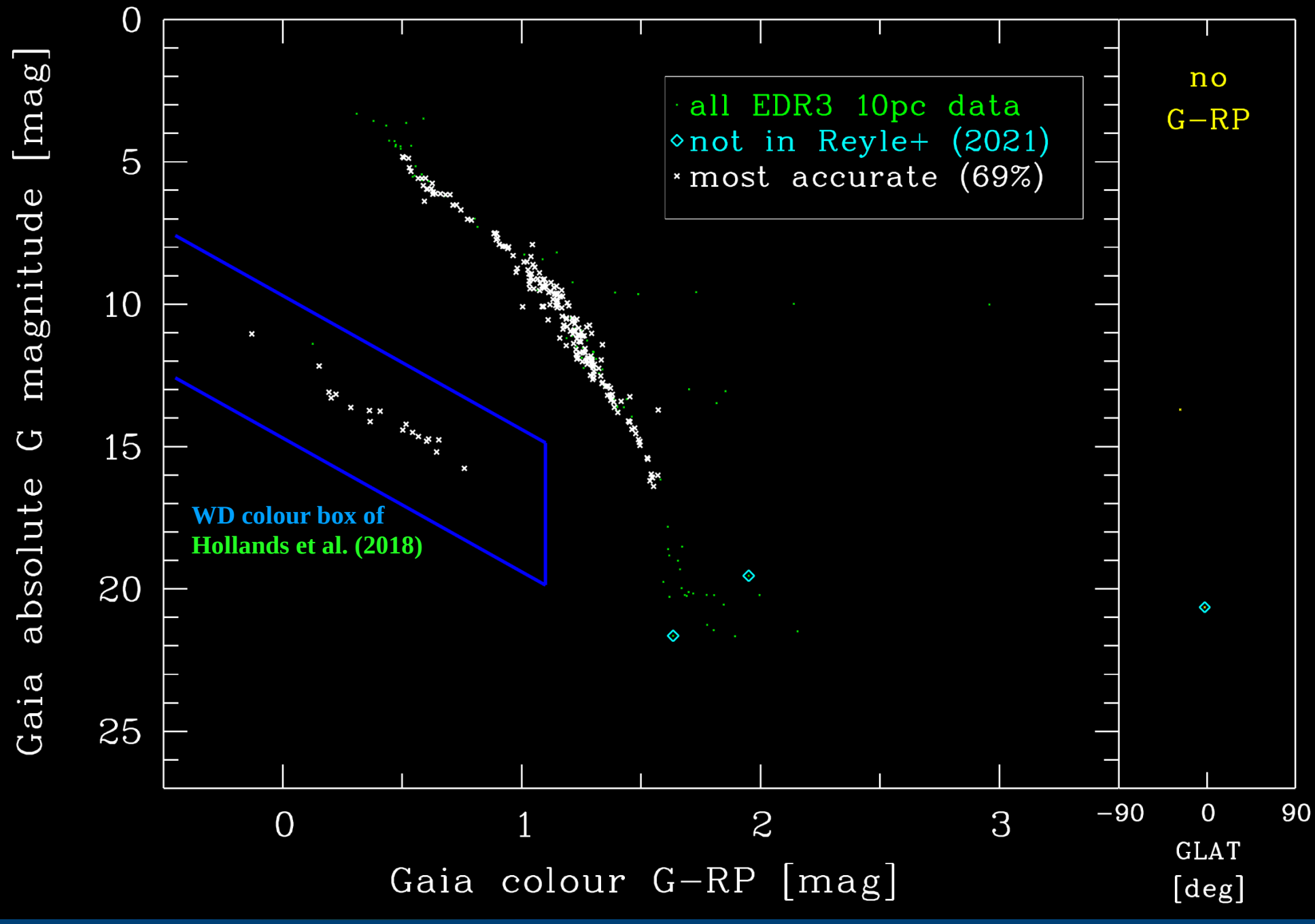


Table 4. Brown dwarfs expected to have a full astrometric solution in future *Gaia* data releases.

Name	Parallax (mas)	Spectral type
Luhman 16 A	501.6 ± 0.1	L7.5
Luhman 16 B	501.6 ± 0.1	T0.5
ϵ Ind C	270.7 ± 0.7	T6.0
SCR J1845–6357 B	249.7 ± 0.1	T6.0
Scholz's Star B	147.1 ± 1.2	T5.0
SCR J1546–5534 B	119.1 ± 0.7	T6.0
2MASS J16471580+5632057	116.0 ± 29.0	L9 pec
2MASS J06523073+4710348 B	109.8 ± 0.3	L6.5
WISE J223617.59+510551.9	102.8 ± 1.9	T5.5
CFBDS J213926+022023 A	101.5 ± 2.0	L8.5
CFBDS J213926+022023 B	101.5 ± 2.0	T3.5
2MASS J07584037+3247245	101.3 ± 3.3	T2.5
BD+16 2708 B	100.5 ± 0.1	M9

The full *Gaia* EDR3 10 pc sample



most accurate:

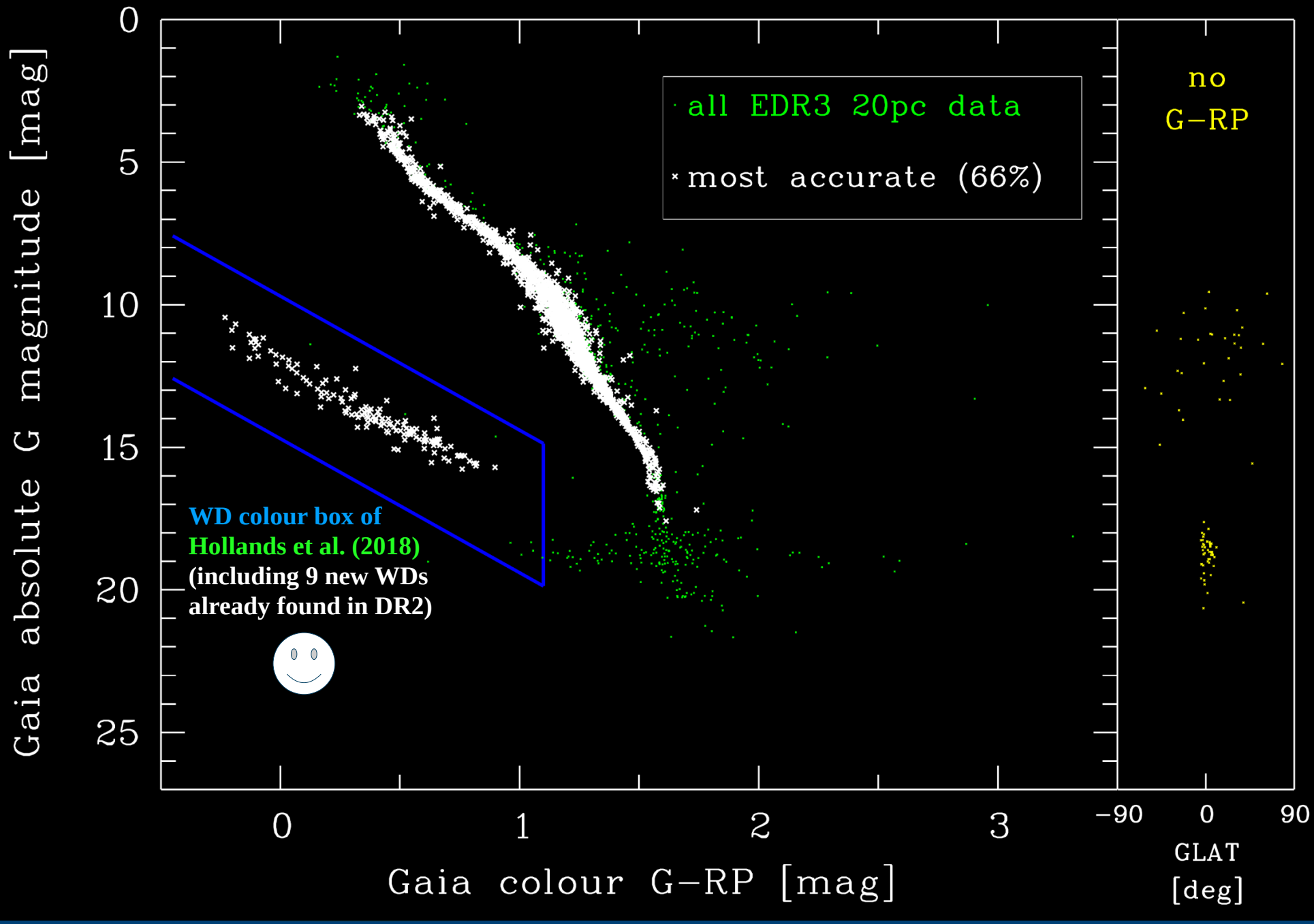
Nper>10
RUWE<1.4

RFBP>10, RFRP>10
BPRPexcessfactor<
$1.3+0.06*(BP-RP)^2$

Using all 315 objects with measured parallaxes from Gaia Collaboration (2020) (2 objects not shown - no Gmag)

Only 3 objects (1%) not in Reyle et al. 2021 (crowding)

The full *Gaia* EDR3 20 pc sample



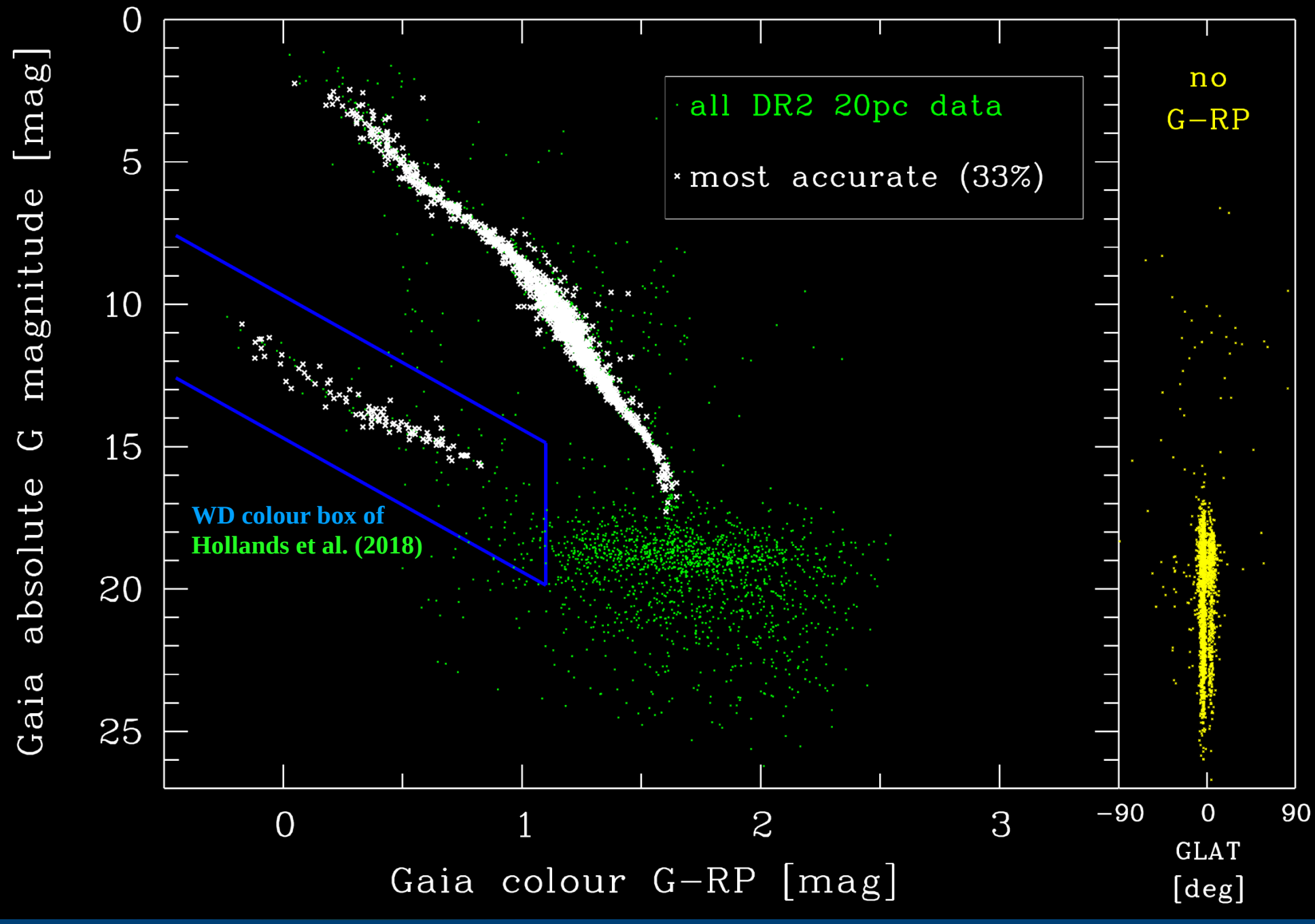
most accurate:

Nper>10
RUWE<1.4

RFBP>10, RFRP>10
BPRPexcessfactor<
$1.3+0.06*(BP-RP)^2$

Using all 2756 objects with measured parallaxes from Gaia Collaboration (2020) (6 objects not shown - no Gmag)

The full *Gaia* DR2 20 pc sample



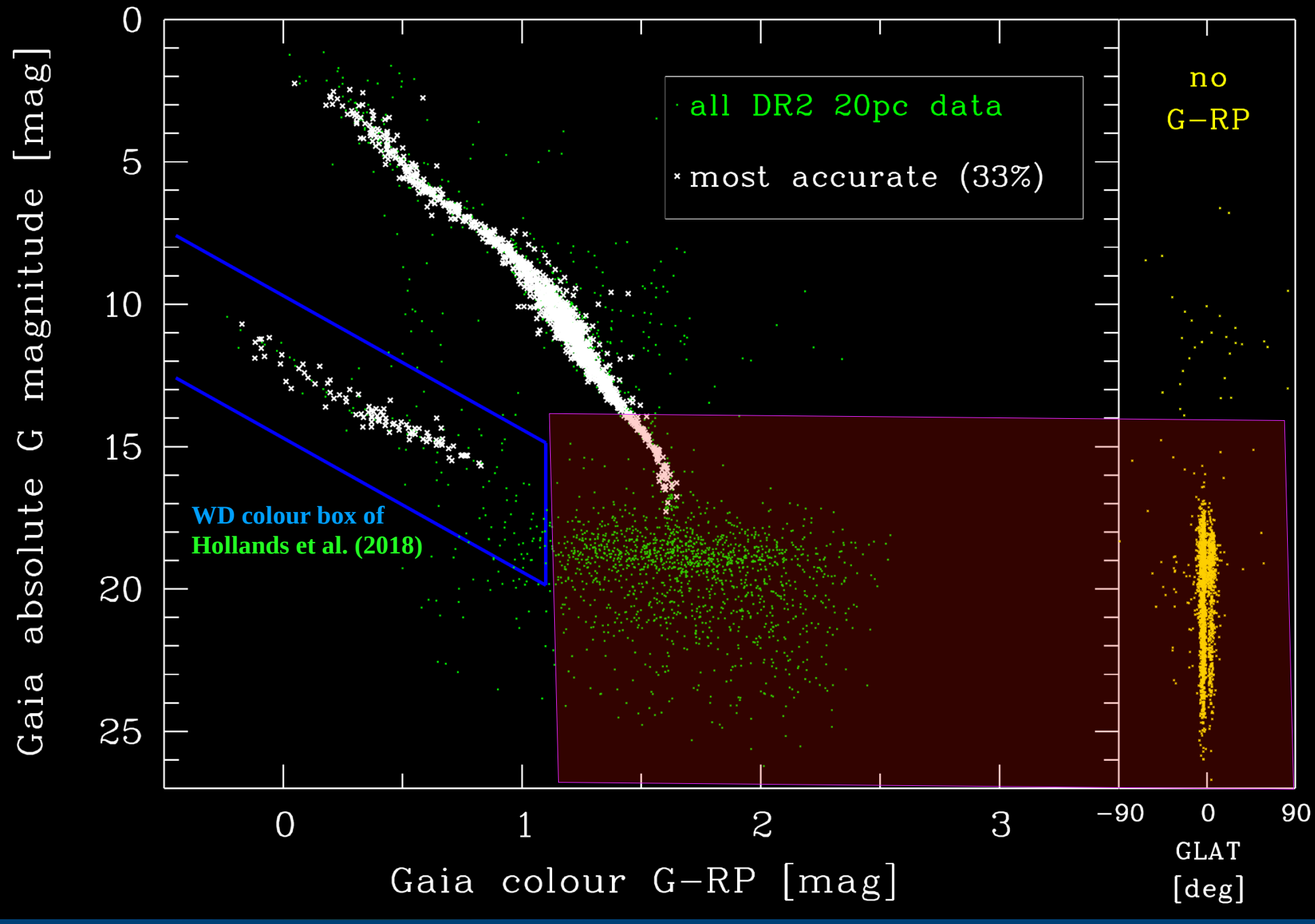
most accurate:

Nper>10
RUWE<1.4

RFBP>10, RFRP>10
BPRPexcessfactor<
$1.3+0.06*(BP-RP)^2$

Using all 6105 objects with measured parallaxes from Gaia Collaboration (2018)

The full *Gaia* DR2 20 pc sample

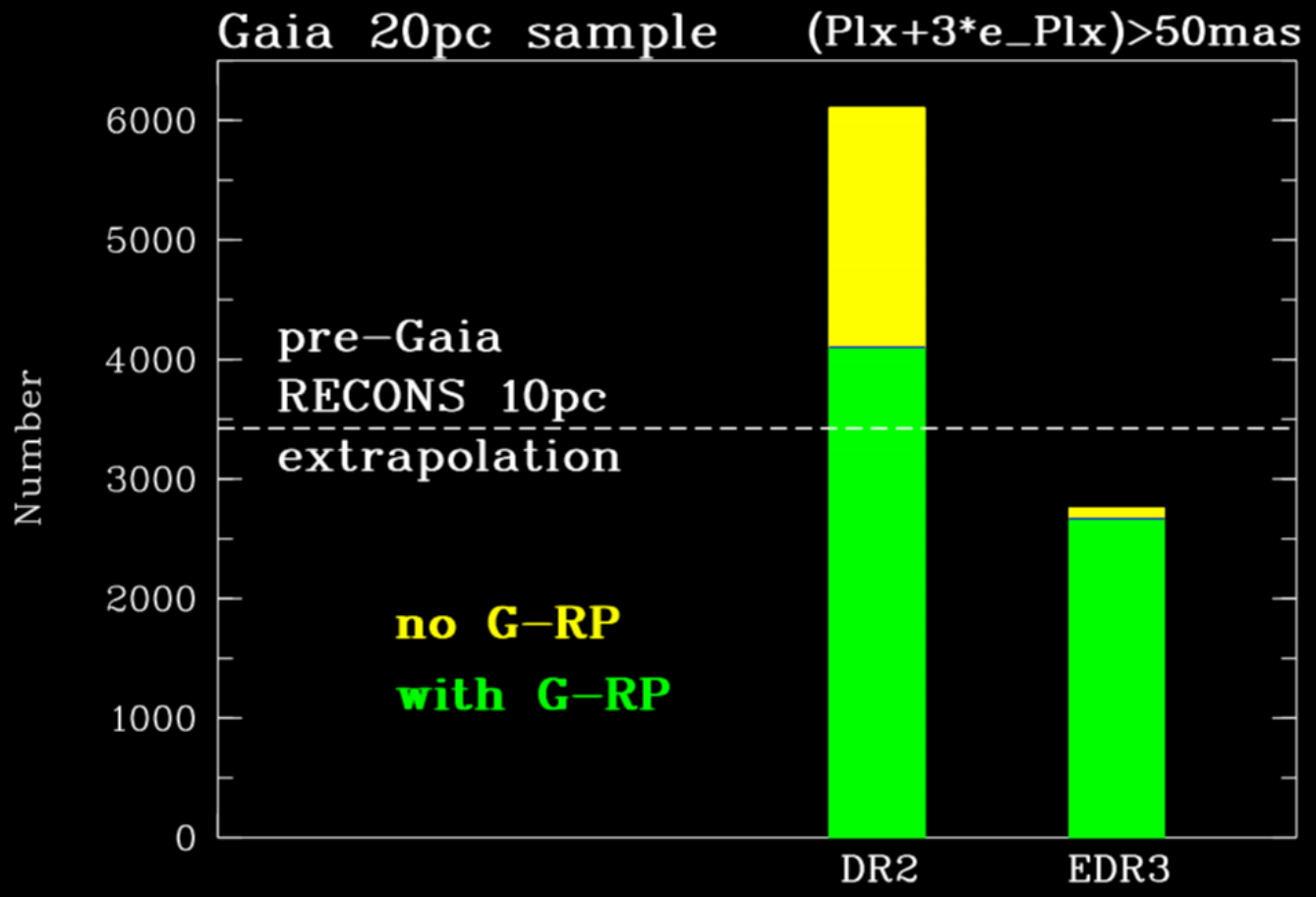


ultracool dwarfs (UCDs) of spectral types >≈ M7 studied by Scholz (2020)

50 new candidates from *Gaia* DR2 confirmed by proper motion check

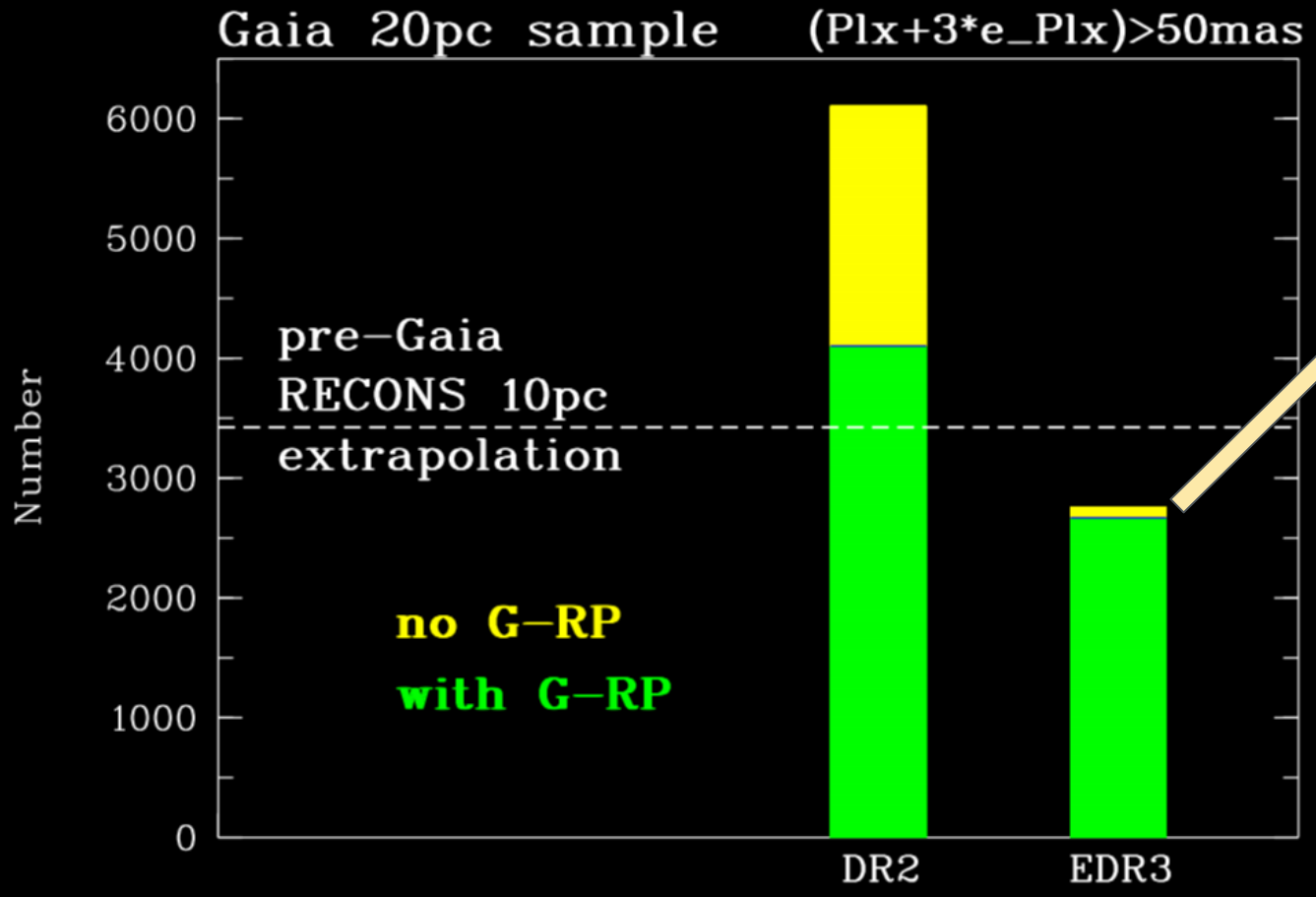
Using all 6105 objects with measured parallaxes from Gaia Collaboration (2018)

Gaia EDR3 contains less false neighbours (d<20pc) but is still incomplete



Using all stars with measured parallaxes from Gaia Collaboration (2018, 2020)

Gaia EDR3 contains less false neighbours (d<20pc) but is still incomplete

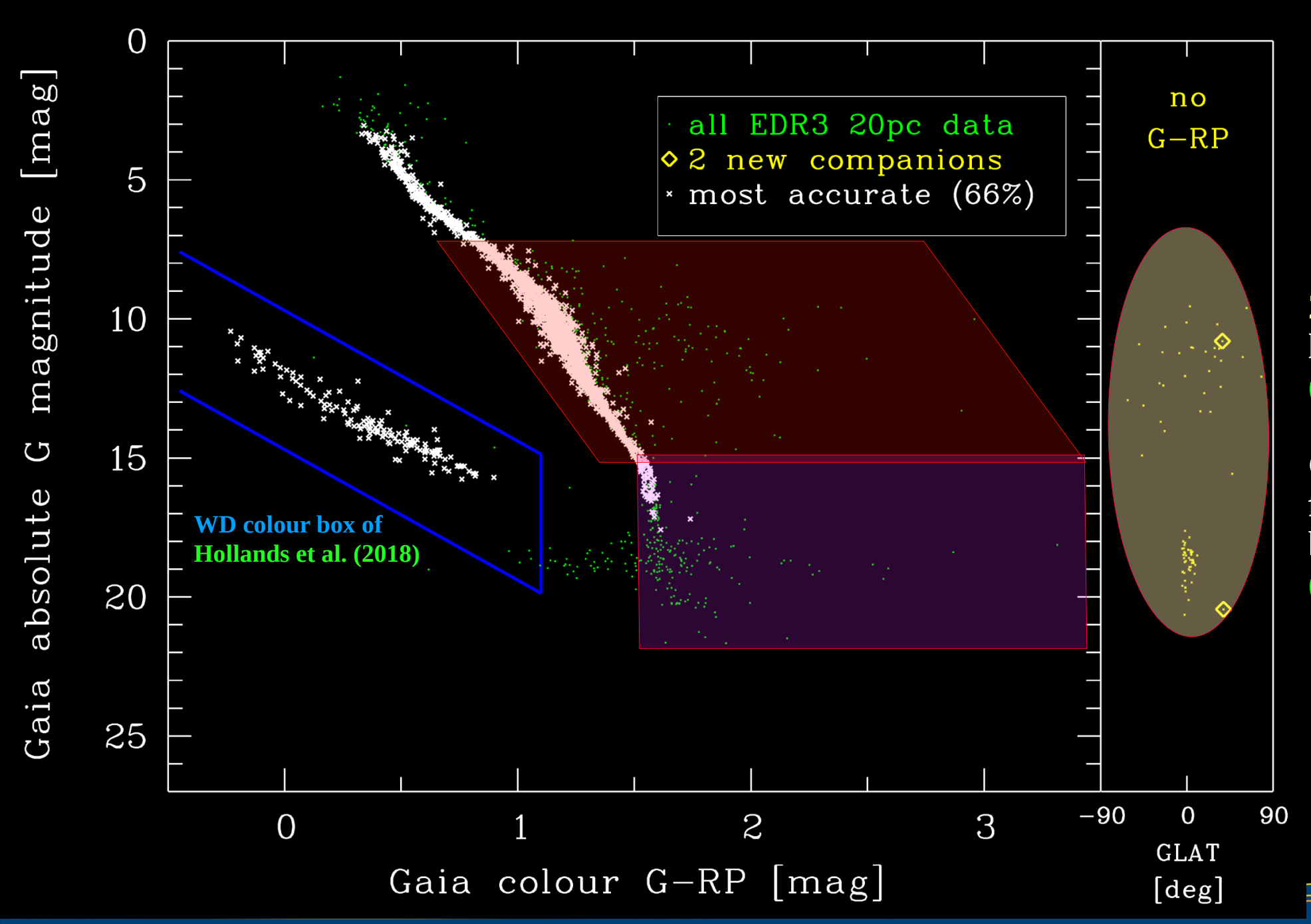


Using all stars with measured parallaxes
from Gaia Collaboration (2018, 2020)

Checking 88 objects without *G-RP* (Scholz 2021):

- 48 faint objects in Galactic plane (crowding!)
- 5 known mid-L dwarfs
- 35 faint components in close common parallax and proper motion (CPPM) pairs incl.
  - * mostly known M dwarfs
  - * two known L dwarfs
  - * one known white dwarf
  - * two new companions of nearby stars

New neighbours in *Gaia* EDR3 20 pc sample?

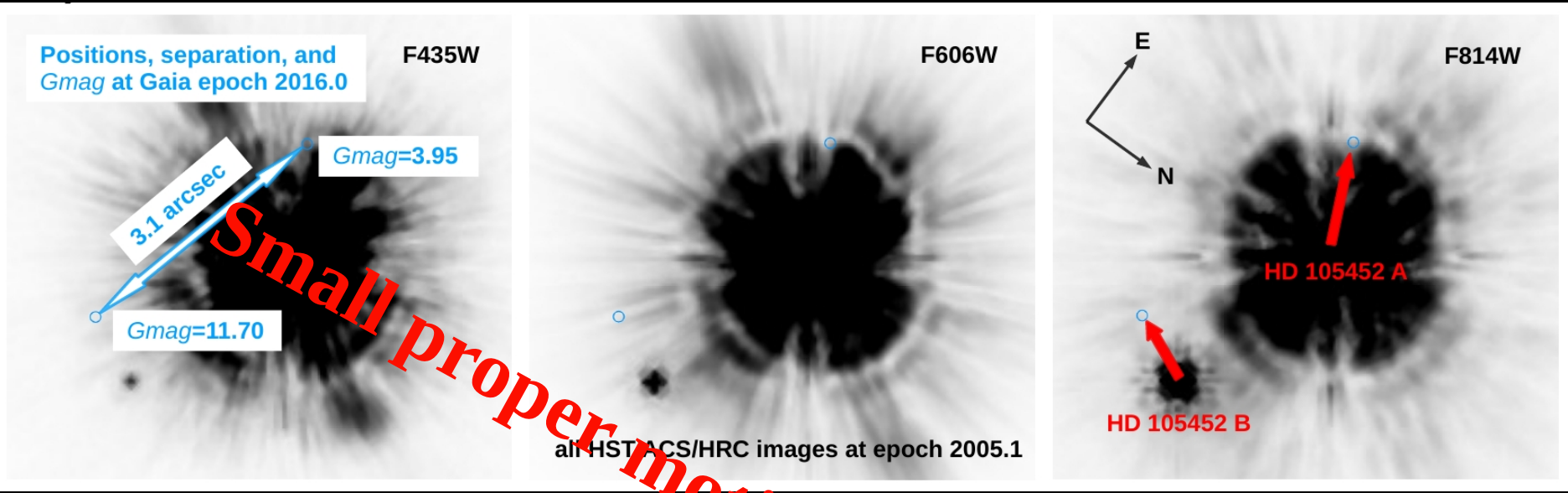


2 new companions lacking G-RP colours (Scholz 2021)

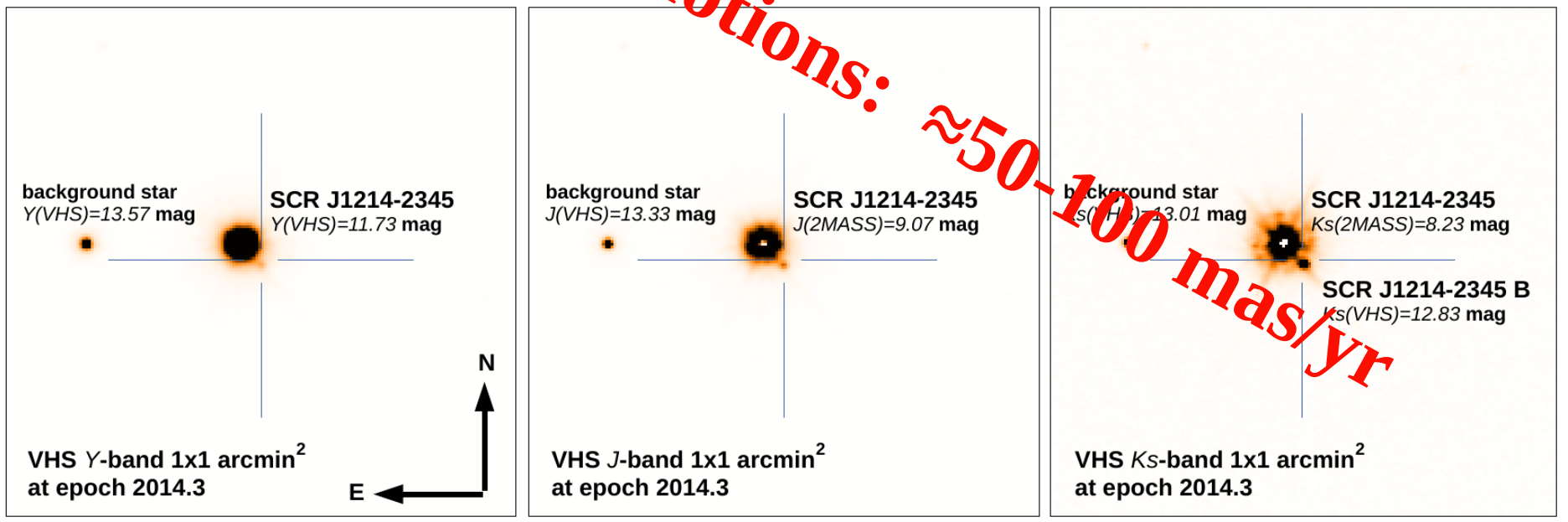
Colour boxes to search for new red dwarfs/BDs by proper motion check (Scholz, in prep.)

Using all 2756 objects with measured parallaxes from Gaia Collaboration (2020) (6 objects not shown - no Gmag)

Two new companions of nearby stars in *Gaia* EDR3 (Scholz 2021)



Small proper motions: ≈50-100 mas/yr



HD 105452 B

companion of *F1* star @ 15 pc
Gmag ≈ *11.70*

red colour from *HST* (Duchene et al. 2014) and *absolute G magnitude* ≈ *10.80* correspond to SpT_{phot} ≈ M4 (Cifuentes et al 2020)

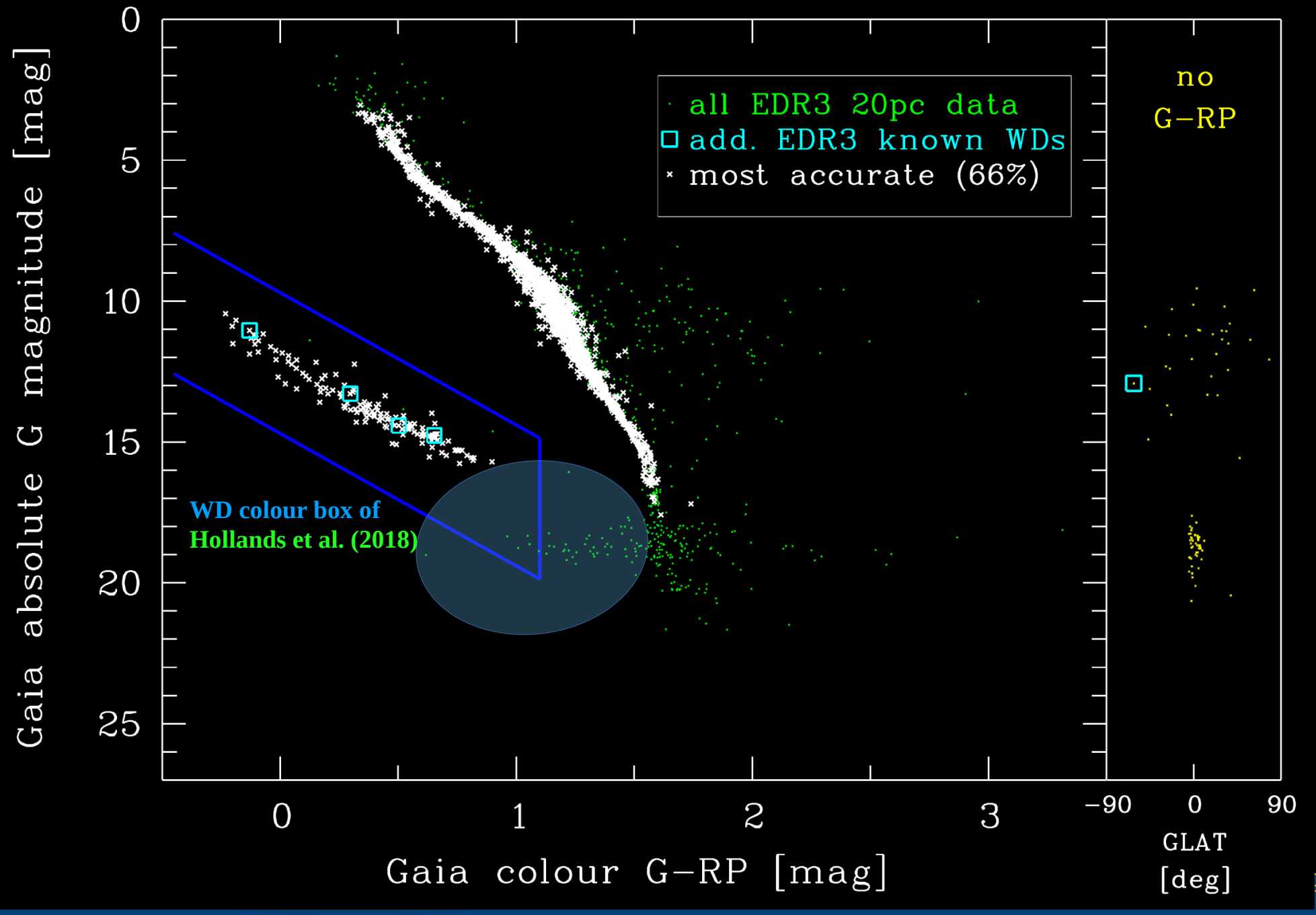
differential proper motion indicates orbital motion

SCR J1214-2345 B

companion of M4.5 dwarf @ 11pc
Gmag ≈ *20.58*

only K_S-band detection in VHS (McMahon et al. 2013) *absolute G magnitude* ≈ *20.45* and *absolute K_S magnitude* ≈ *12.70* lead to SpT_{phot} ≈ T4-T5 and ≈ L8, respectively (Reyle 2018)

White dwarfs in *Gaia* EDR3 20 pc sample

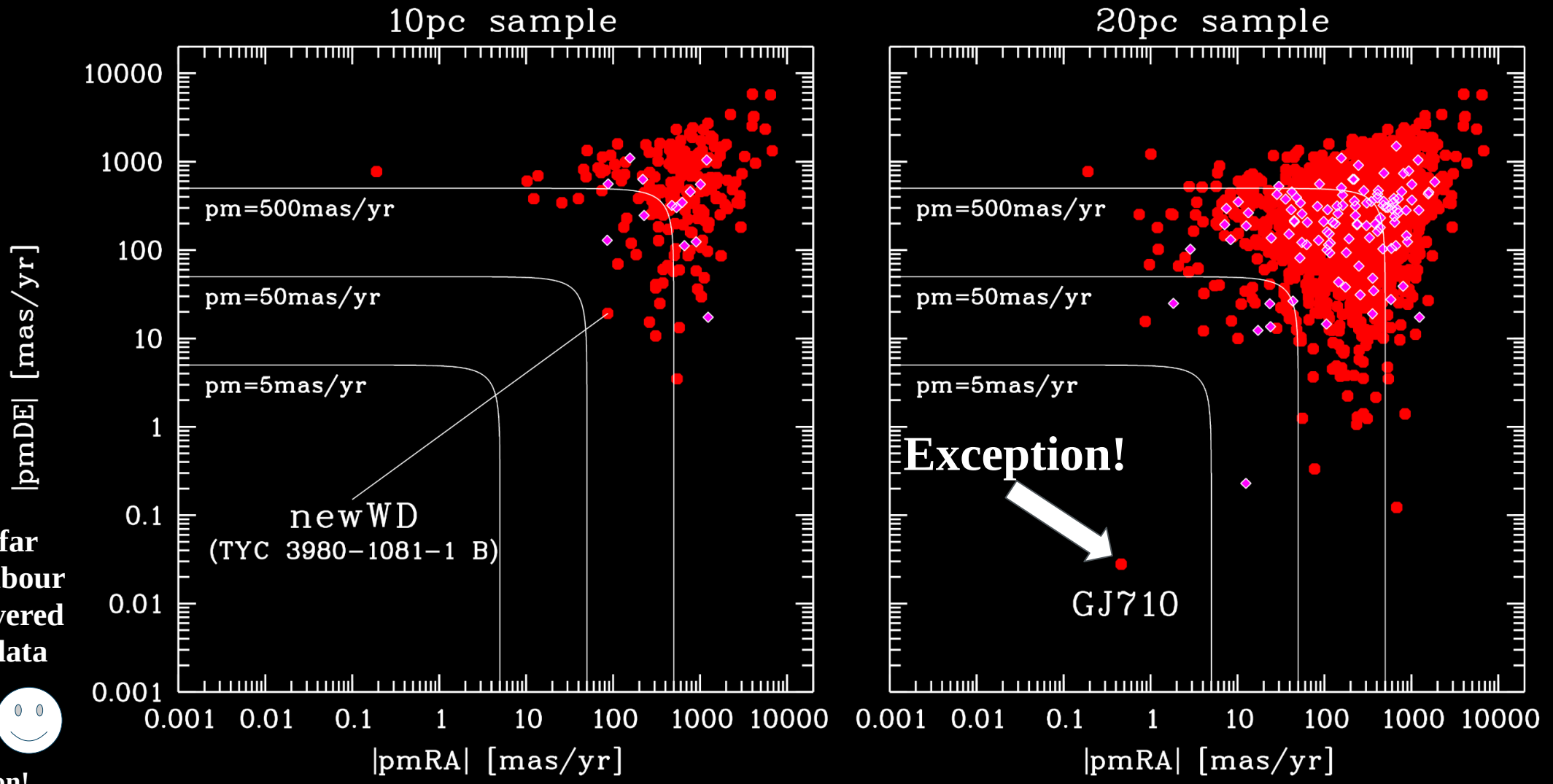


5 known WDs added to DR2 sample of 139 WDs of Hollands et al. (2018)

No new WDs in/next to WD colour box could be confirmed by proper motion check (Scholz, in prep.)

Using all 2756 objects with measured parallaxes from Gaia Collaboration (2020) (6 objects not shown - no Gmag)

Rule of thumb: Nearby stars = high proper motion (HPM) stars



The new WD is so far the only new neighbour within 10 pc discovered with help of *Gaia* data (Scholz et al. 2018a)

… and it has the smallest proper motion!

Selected *Gaia* DR2 high astrometric quality data (Scholz 2020)

Outlook

Gaia **ist still incomplete, but for the first time it provides an unbiased survey, with respect to proper motions, for the nearest stars (and BDs)**

Gaia **helps to discover new neighbours with relatively small proper motions and/or as components in (unresolved) multiple systems**

Proper motion checks remain to be a useful tool for the study of problematic *Gaia* measurements of large parallaxes in crowded fields (source confusion)

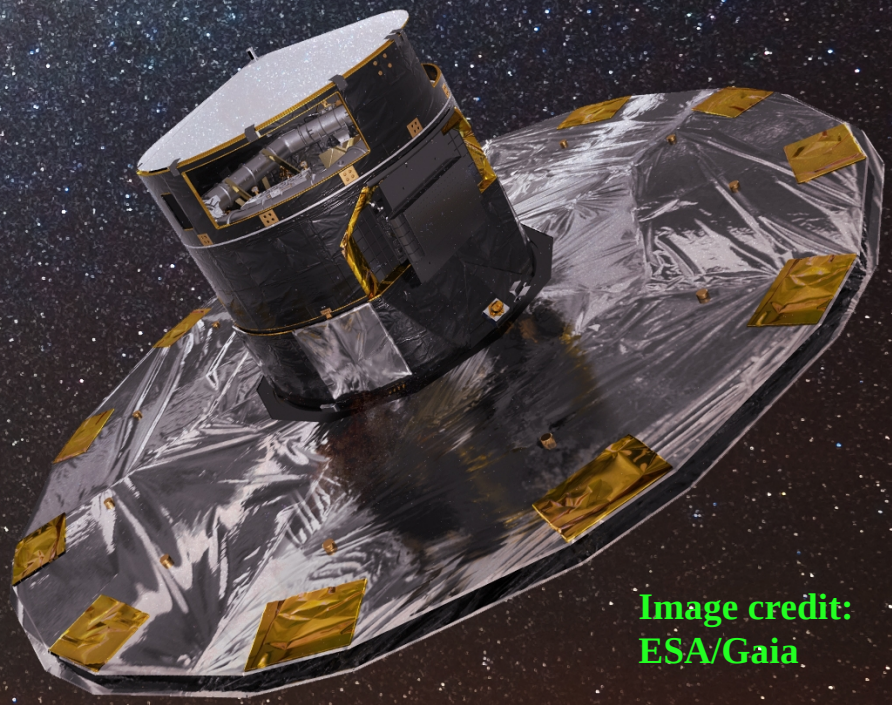


Image credit: ESA/Gaia