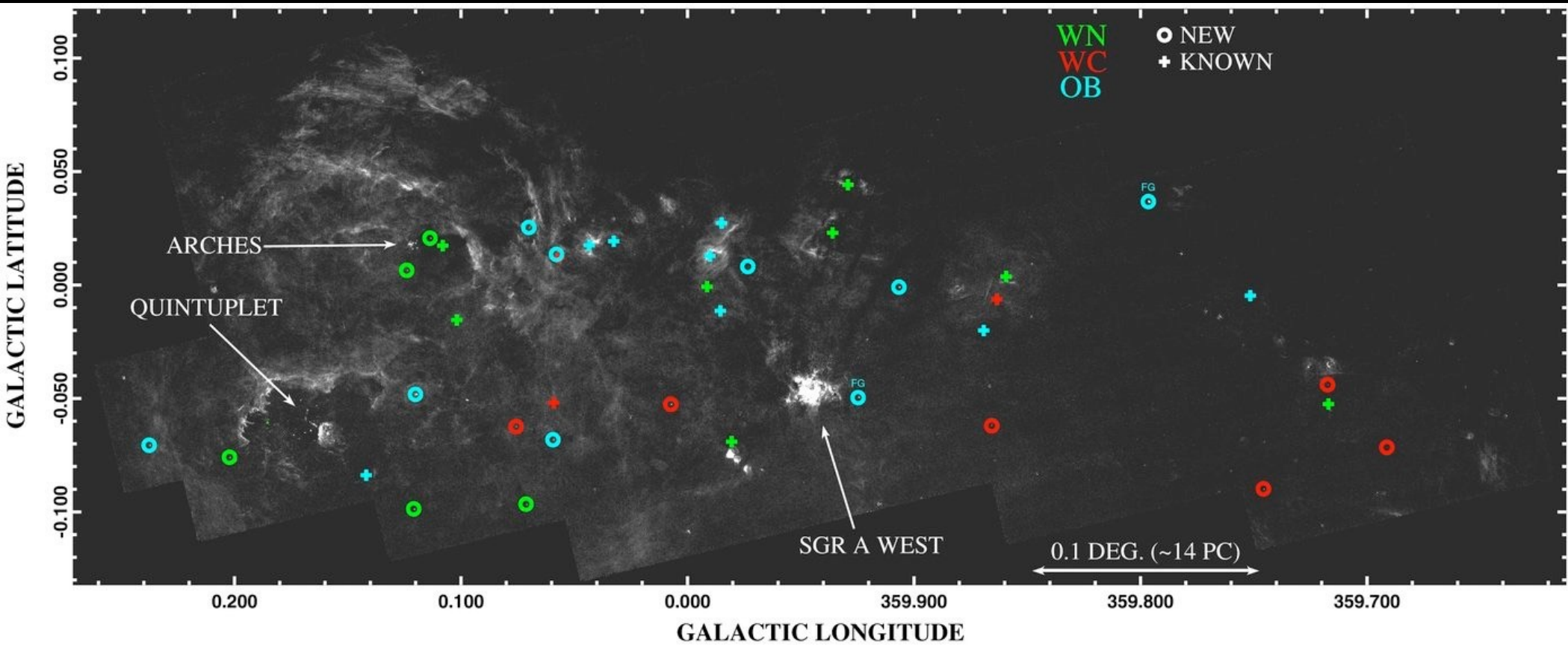


# Hubble astrometry and proper motions of isolated massive stars near the Galactic Center



Danny Lennon (IAC)  
Mattia Libralato (STScI)  
Andrea Bellini (STScI)  
Roeland van der Marel (STScI)

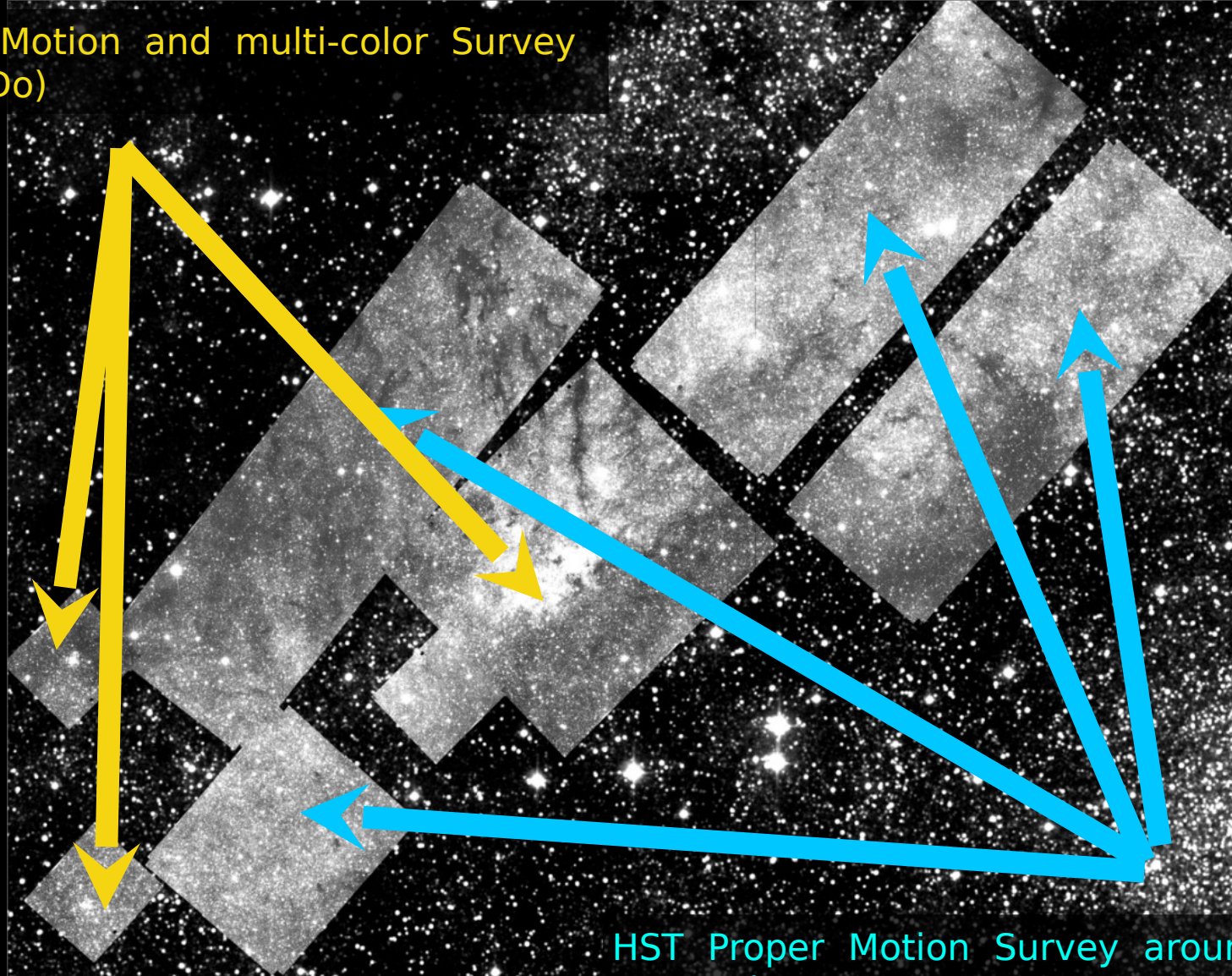
# Isolated Massive Stars (after Mauerhan et al 2010, Wang et al 2010 HST/NICMOS P $\alpha$ Survey)



# Proper motions of isolated massive stars near the Galactic Center

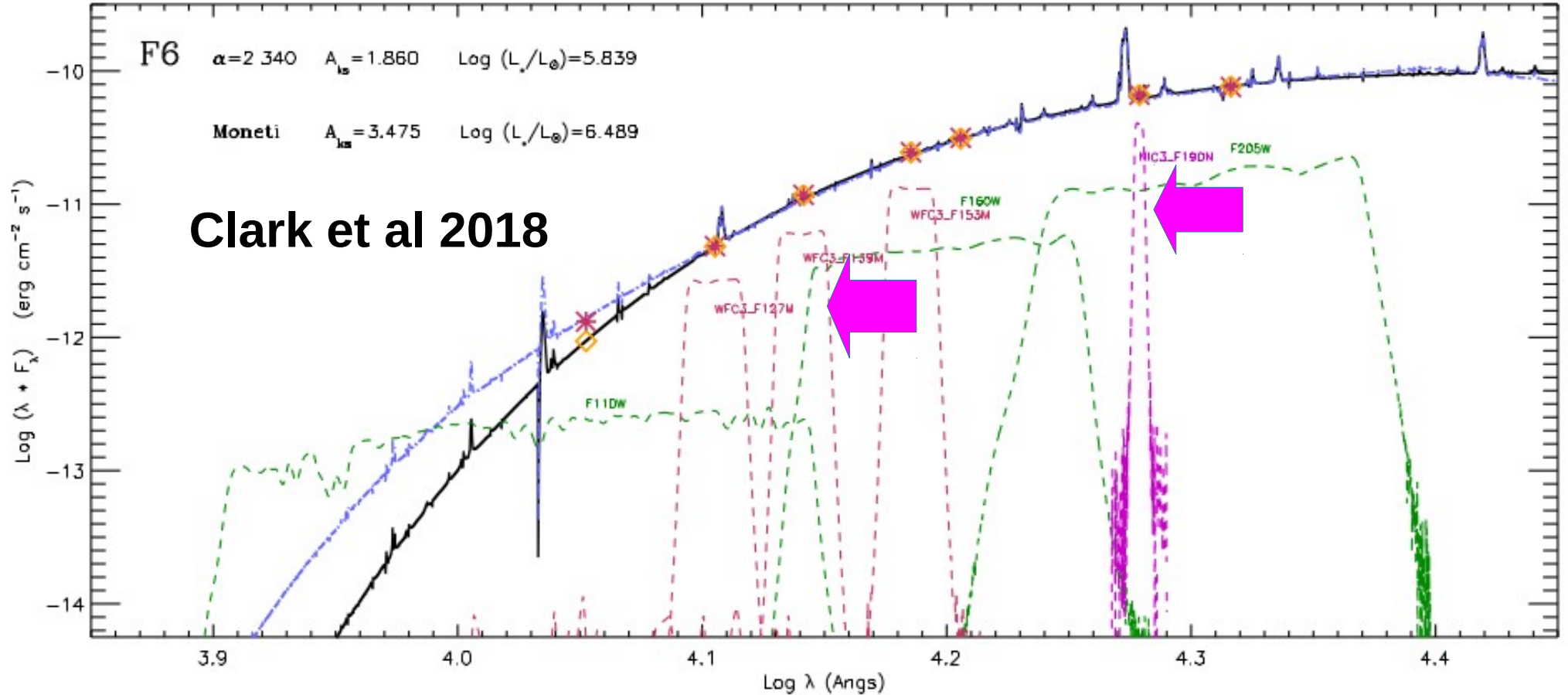
- Monochromatic (F139M) survey of intra-cluster spaces
- Two epochs (2x18 orbits) 3 years apart, in 2012 and 2015
- Cols:
  - Danny Lennon (IAC)
  - Selma de Mink (Harvard)
  - Roeland van der Marel (STScI)
  - Jay Anderson (STScI)
  - Chris Evans (STFC, RoE)
  - Paul Crowther (Sheffield University)
  - Tony Sohn (STScI)
  - Luigi Bedin (Observatory of Padua)
  - Imants Platais (Johns Hopkins)
  - Andrea Bellini (STScI)
  - Elena Sabbi (STScI)

HST Proper Motion and multi-color Survey  
(PIs Ghez & Do)

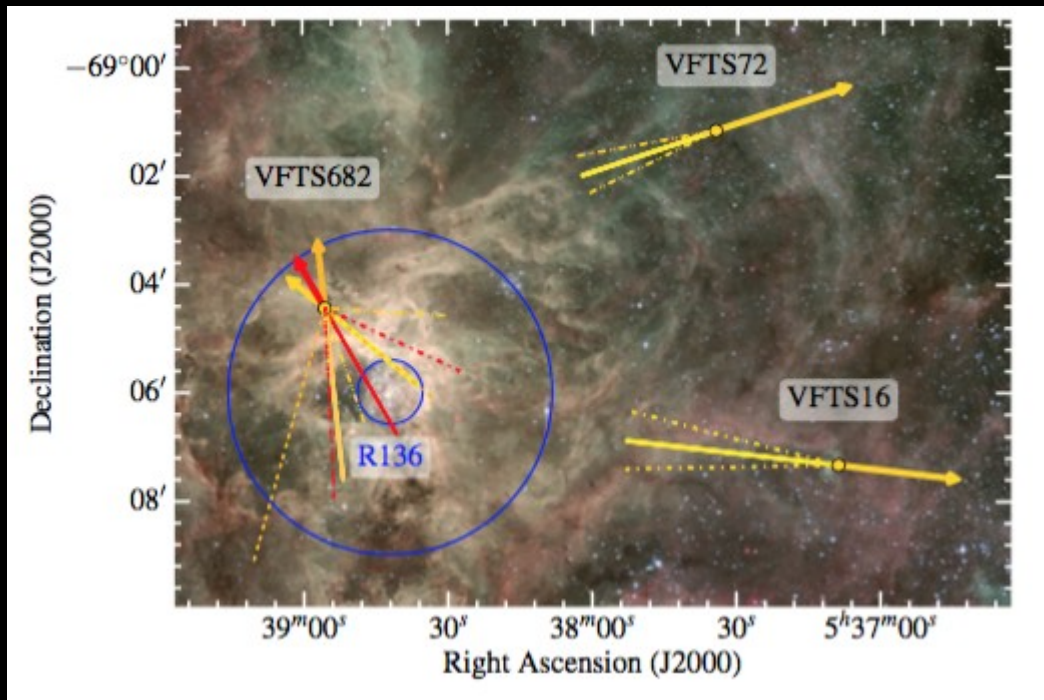


HST Proper Motion Survey around the Galactic  
Center (PI Lennon; GO 12915/13771) F139M filter.

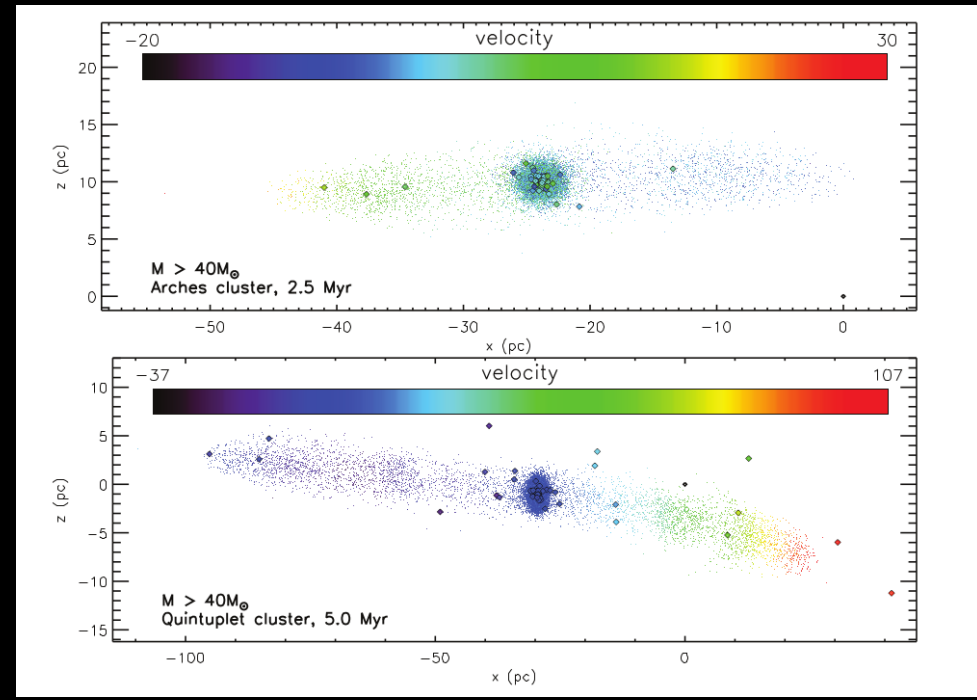
# Emission Line Massive Stars



# Possible explanations: Runaways, walkaways, tidal tails....



Renzo et al 2019

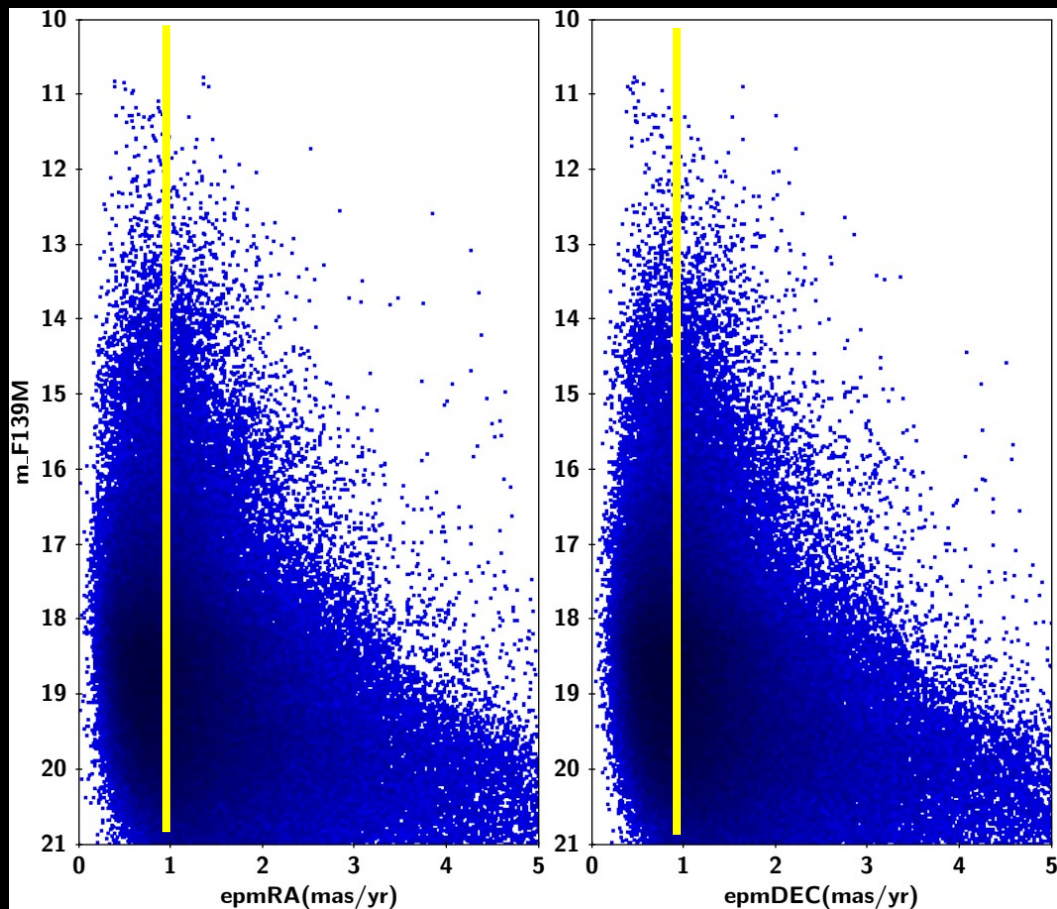
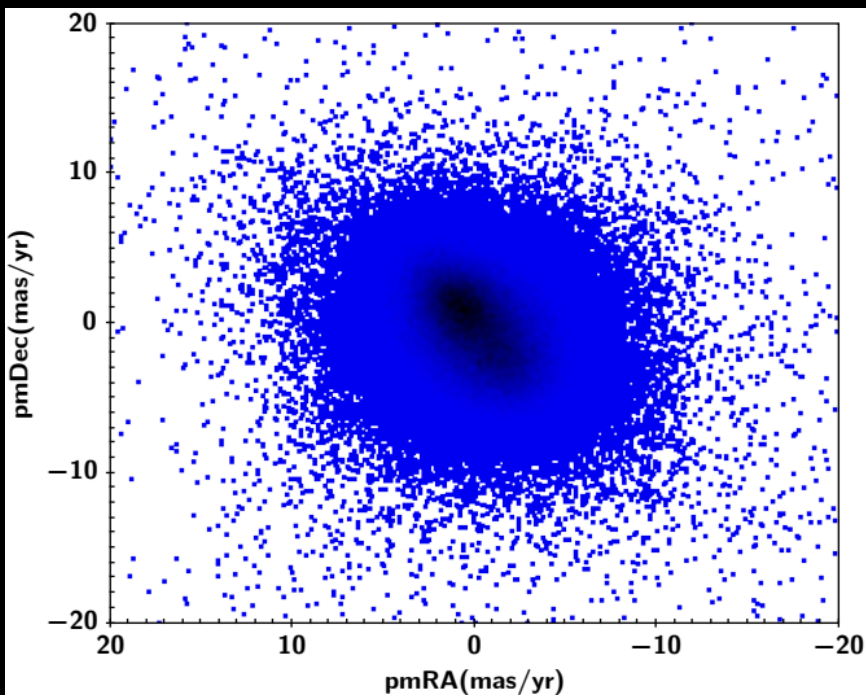


Habibi et al 2014

# Proper Motion catalog generation

- Details as in Bellini et al (2014), ApJ,797,115
- Master astrometric and photometric catalogs for ~397,000 stars
- Down selection to catalog of 141,000 'well measured' stars, the subject of the rest of this talk
- Criteria for inclusion were related to astrometric and photometric quality checks -
- Including detection in the P $\alpha$  photometric catalog of Wang et al (2010), giving an F139M-F190N color.

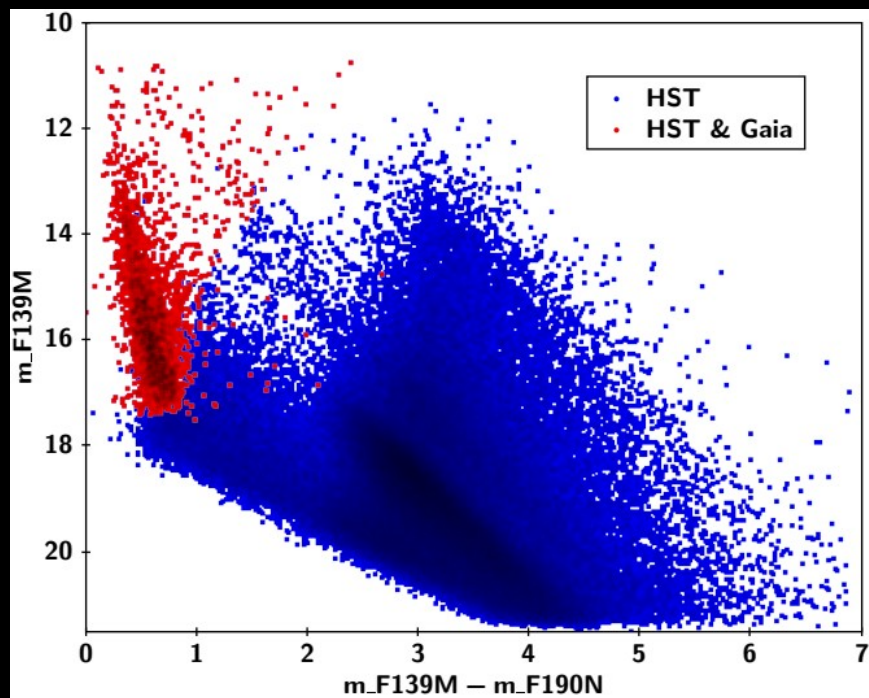
# Relative proper motions and precision



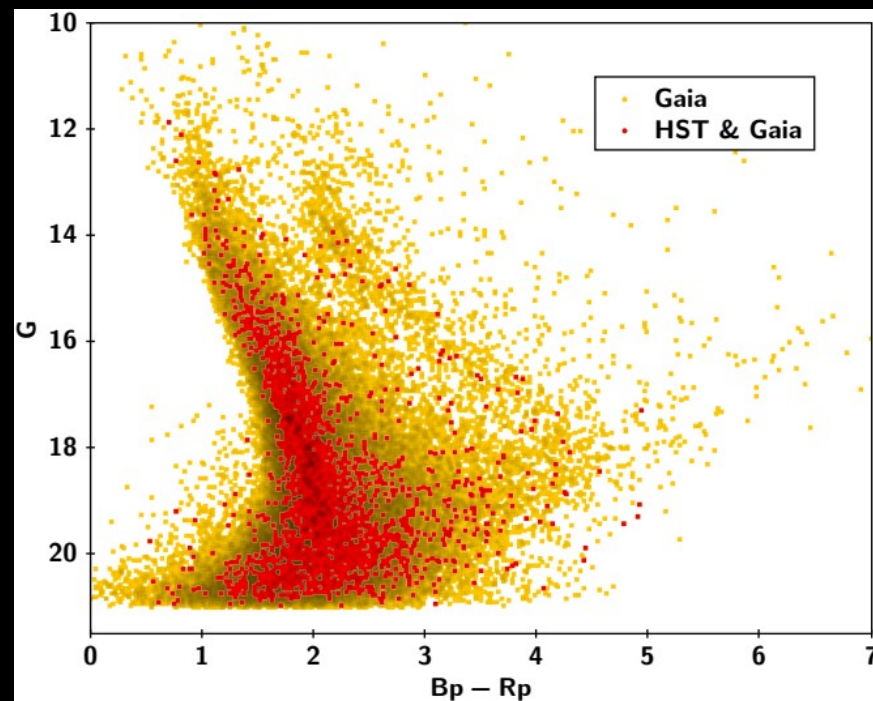
1 mas/yr @ 8 kpc ~ 40 km/s



# Gaia and the absolute pm reference frame



**HUBBLE**

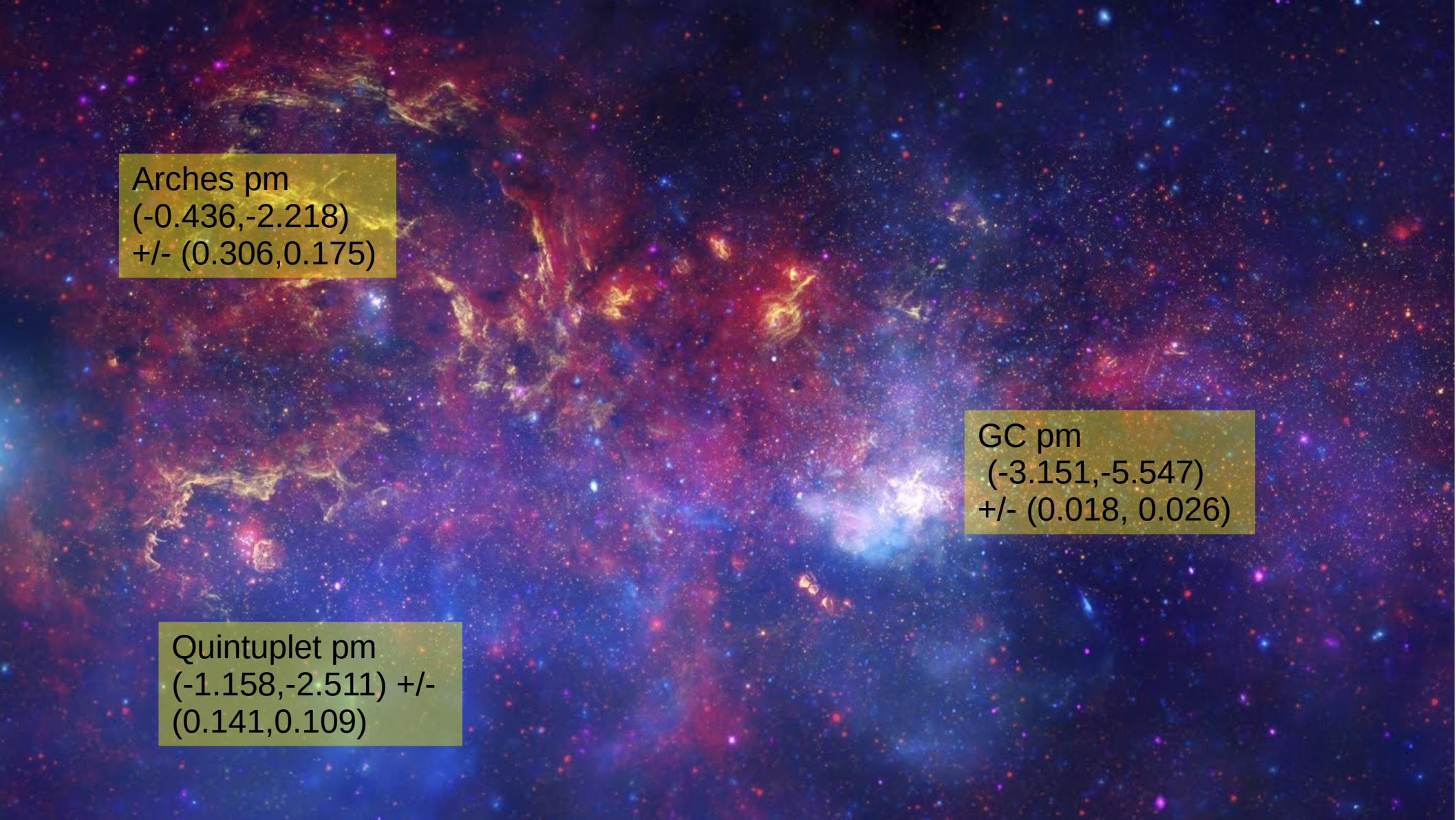


**GAIA**

$$\text{delta}(pm_{\text{HST}} - pm_{\text{Gaia}}) = (2.399, 4.363) \pm (0.037, 0.036) \text{ mas/yr}$$

# Absolute PMs of Arches, Quintuplet and Galactic Center

- The absolute proper motion of GC has been measured (e.g. Reid & Brunthaler 2004)
- Proper motions of the Arches & Quintuplet clusters have been measured *relative* to the Bulge population from AO imaging (Stolte et al 2015).
- However – as for the HST measurements – we use the overlap with Gaia data to transform these measurements to an absolute pm scale.

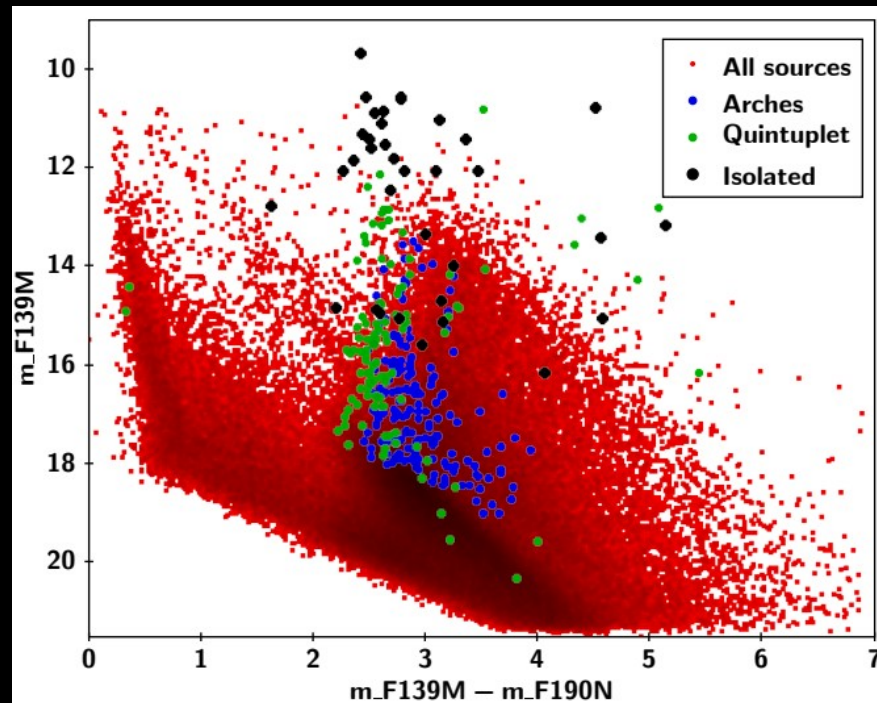
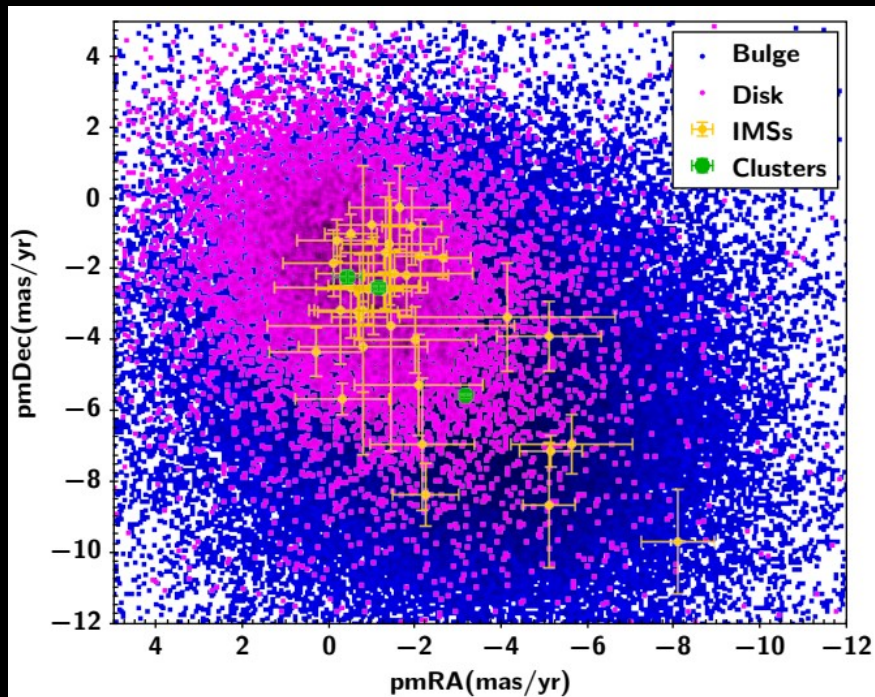


Arches pm  
(-0.436,-2.218)  
+/- (0.306,0.175)

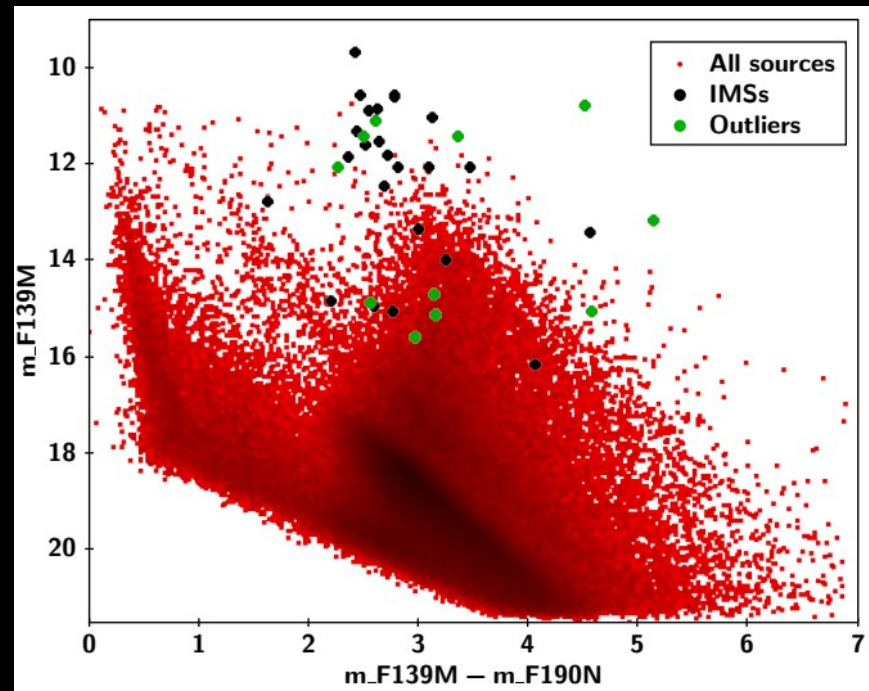
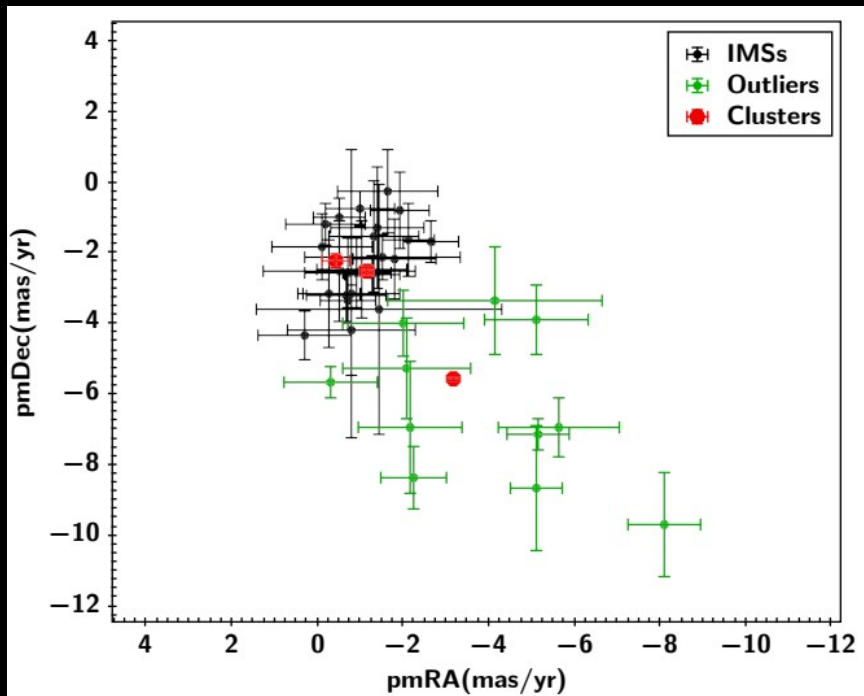
GC pm  
(-3.151,-5.547)  
+/- (0.018, 0.026)

Quintuplet pm  
(-1.158,-2.511) +/-  
(0.141,0.109)

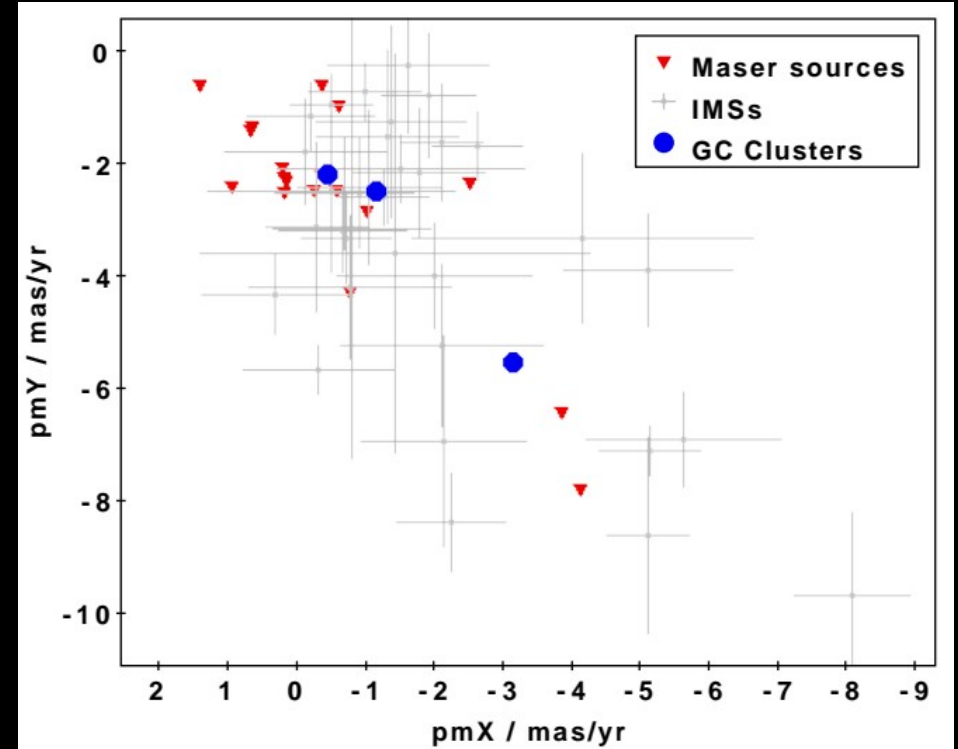
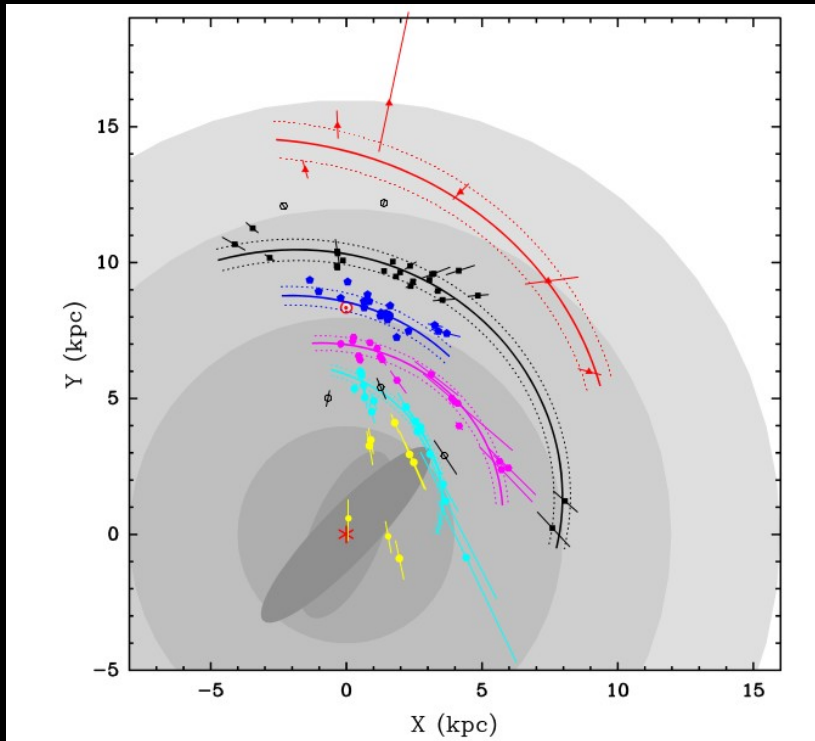
# Preliminary results for IMSs



# Isolated massive stars



# An inner 'disk' origin?



Reid et al (2014) maser sources associated with high mass star forming regions

# Searching for fast moving massive stars...

