The Young Local Associations

Looking for their origin and evolution

- What are they?
- YLA as seen by Gaia
- Gaia capabilities to constrain origin and evolution
- YLA, a Gaia Challenge for DR1

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YLA, what they are?

Several groups of young (mainly low-mass) stars (r<100pc)

Groups?

They share common properties when looking at the X-ray, optical spectroscopy and kinematics data

Young?

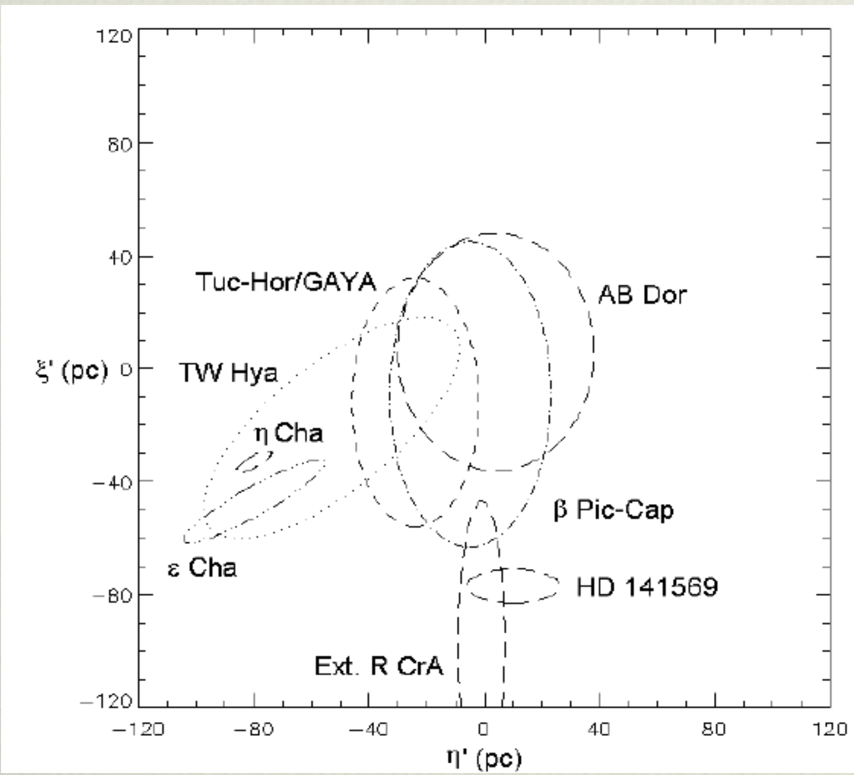
Very young: spectroscopic ages between 10 – 100 Myr

Why Important?

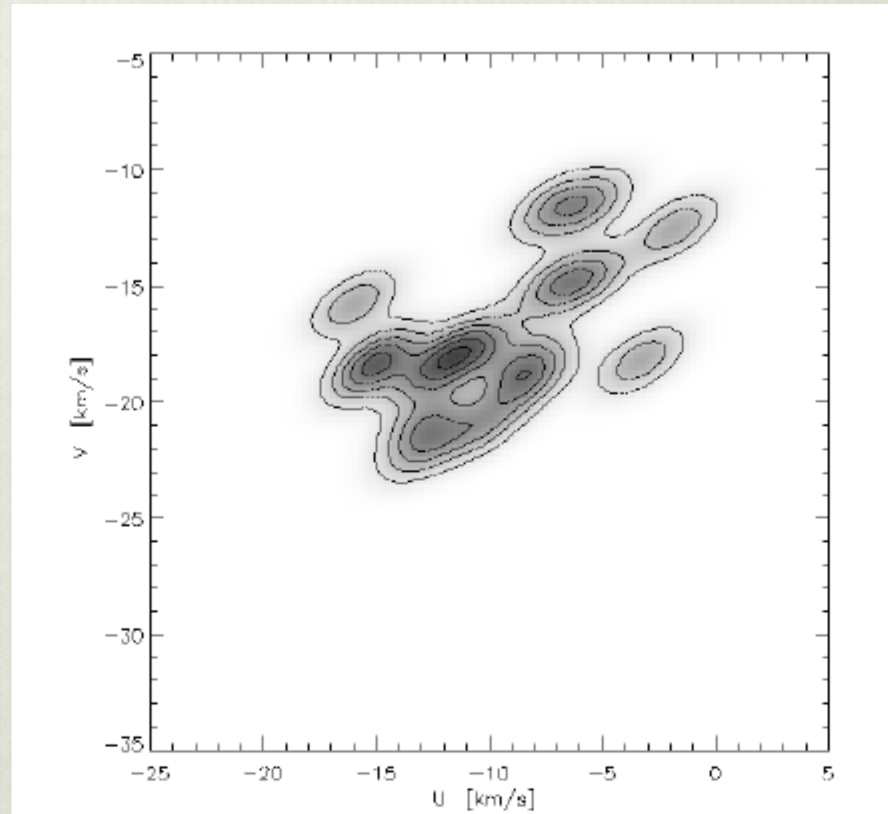
They offer us new insights into the star formation process in the solar neighborhood (low-density environments)

YLA from Hipparcos

Position



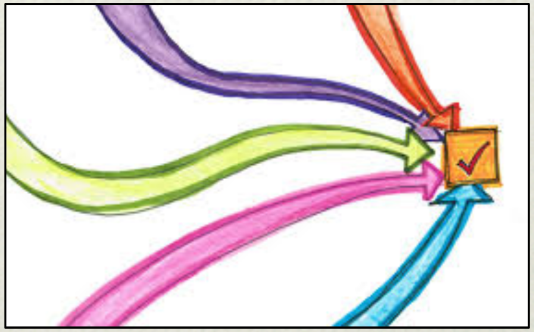
Velocities



TW Hydra

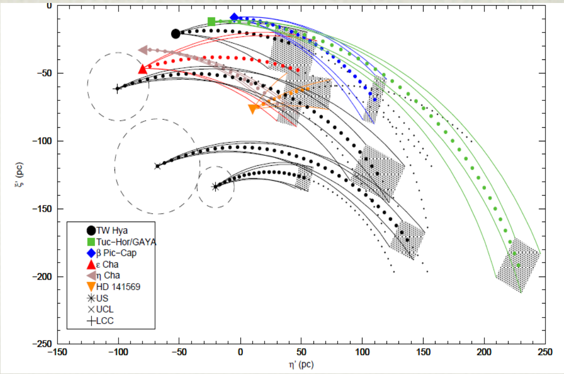
Goals:

Derivation of a dynamical age for each association. Do they match with HR ages?



Star formation in low density environments
Triggered star formation?

Centers of the associations back in time
Do they have a common origin?



Linked to spiral arms shock wave?
Molecular cloud compression?

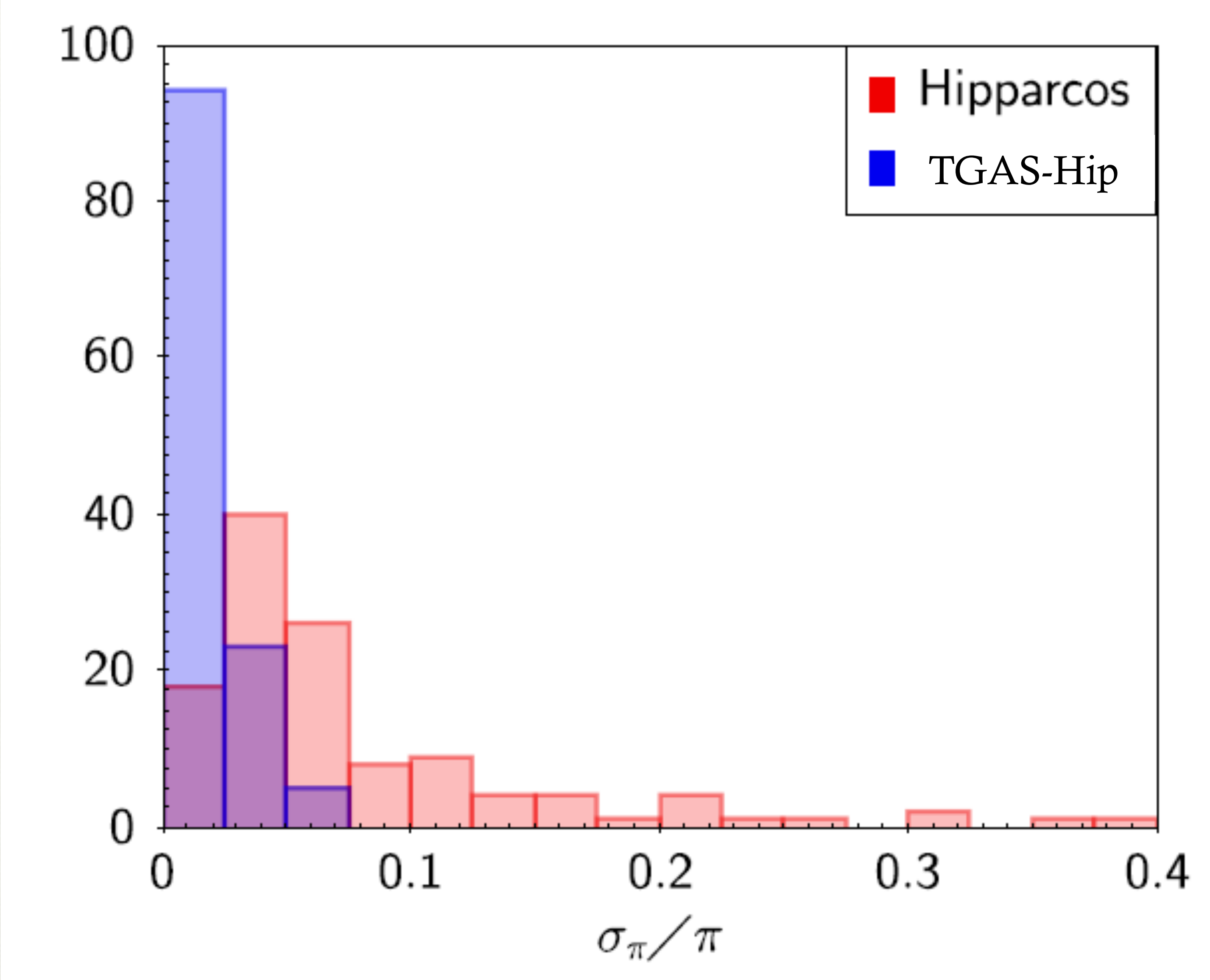
YLA as seen by Gaia:

- Better astrometry (distances and tangential velocities)
- Detection of new members (Grand Challenge)
- Complementary on-ground RV data and chemistry

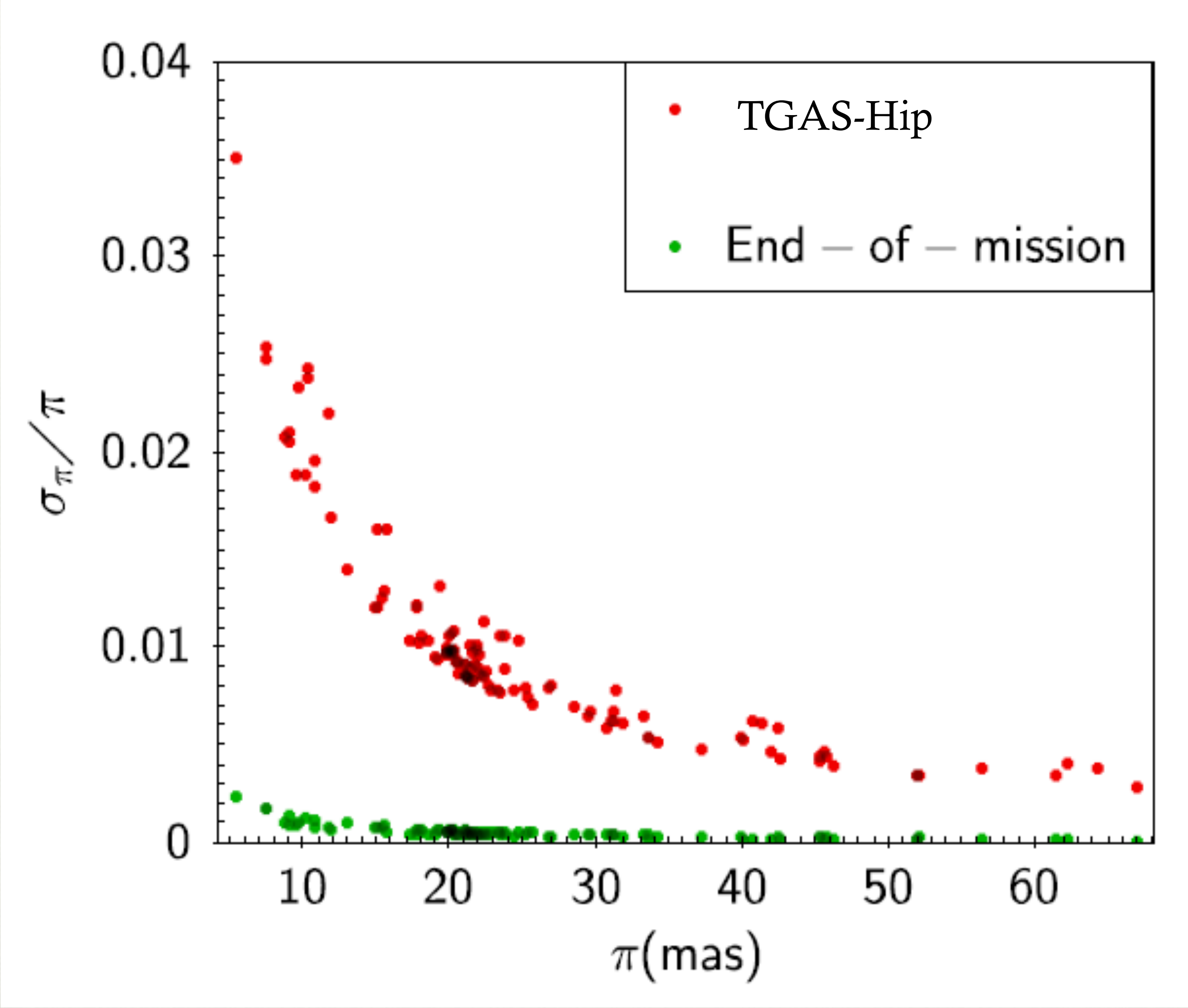
Our exercise:

	N	$< V >$	Astrometric accuracy	σ_{VR} (km/s)
Before Gaia	20	9	Hipparcos	4
DR1 TGAS-Hip	20	9	DR1-Hipp	2
DR1 TGAS-Tyc	50	11	DR1-Tycho	2
Gaia+	100	13	end-of-mission	0.5

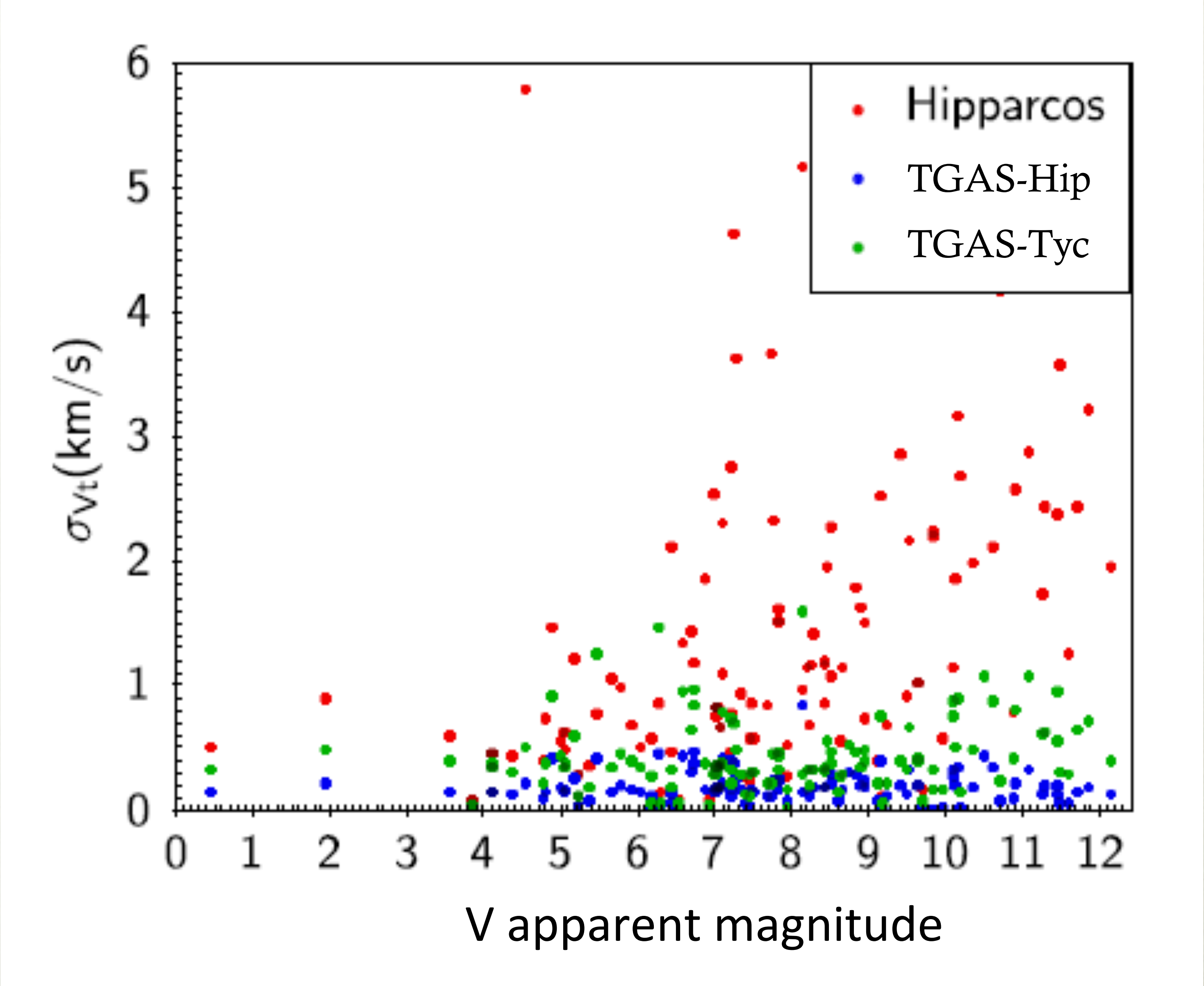
Distance accuracy for the known YLA



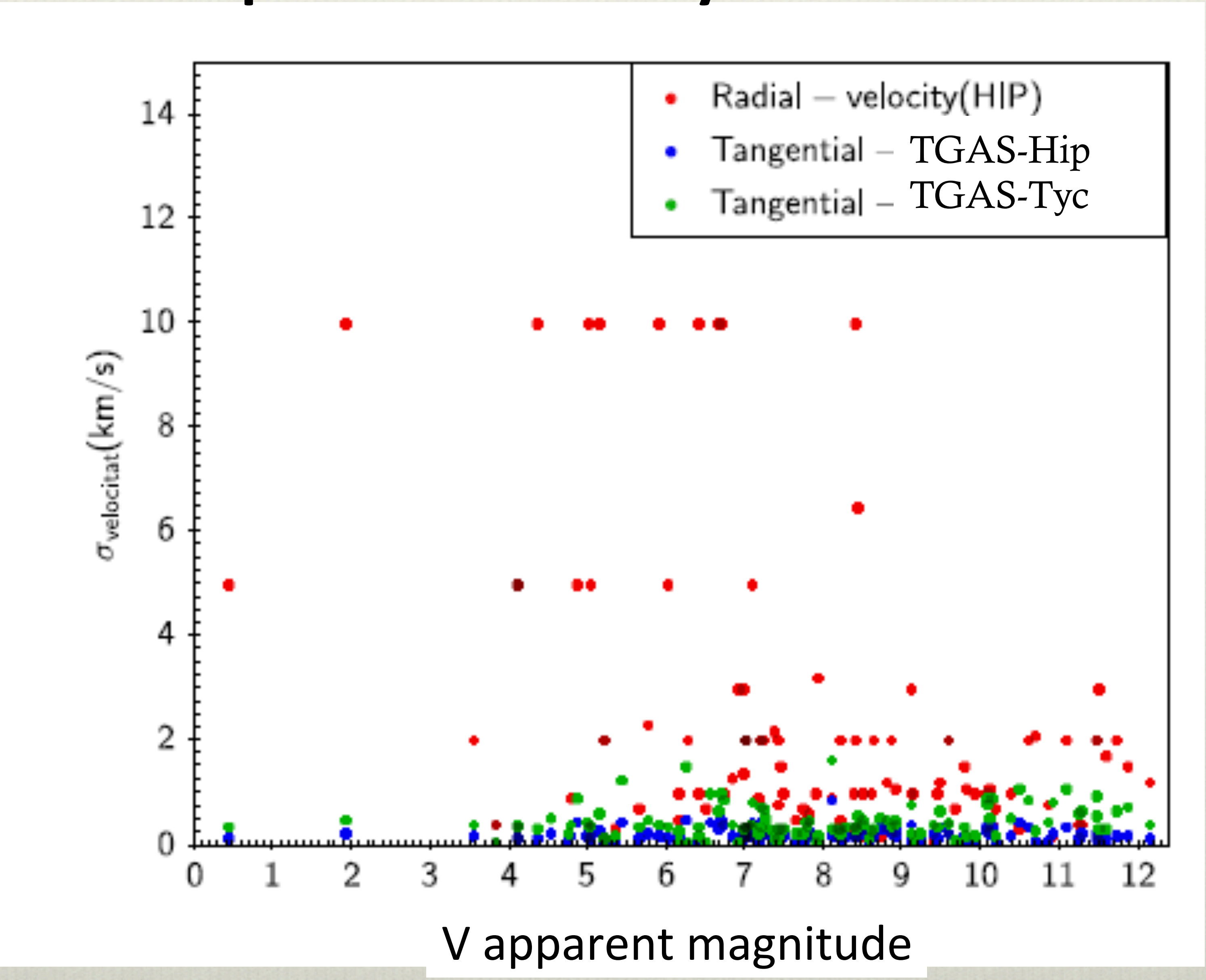
Distance accuracy for the known YLA



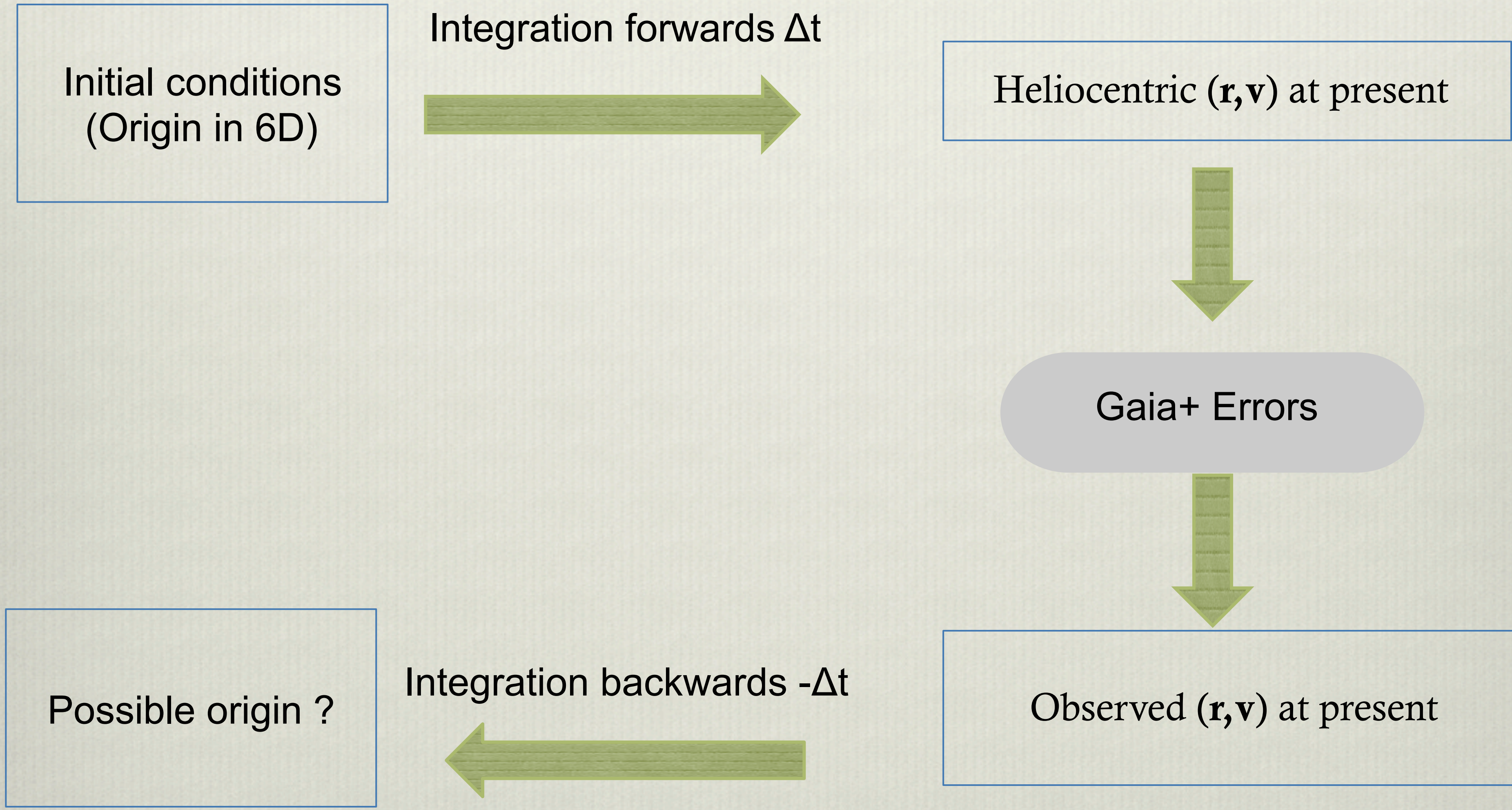
YLA expected accuracy in tangential velocities



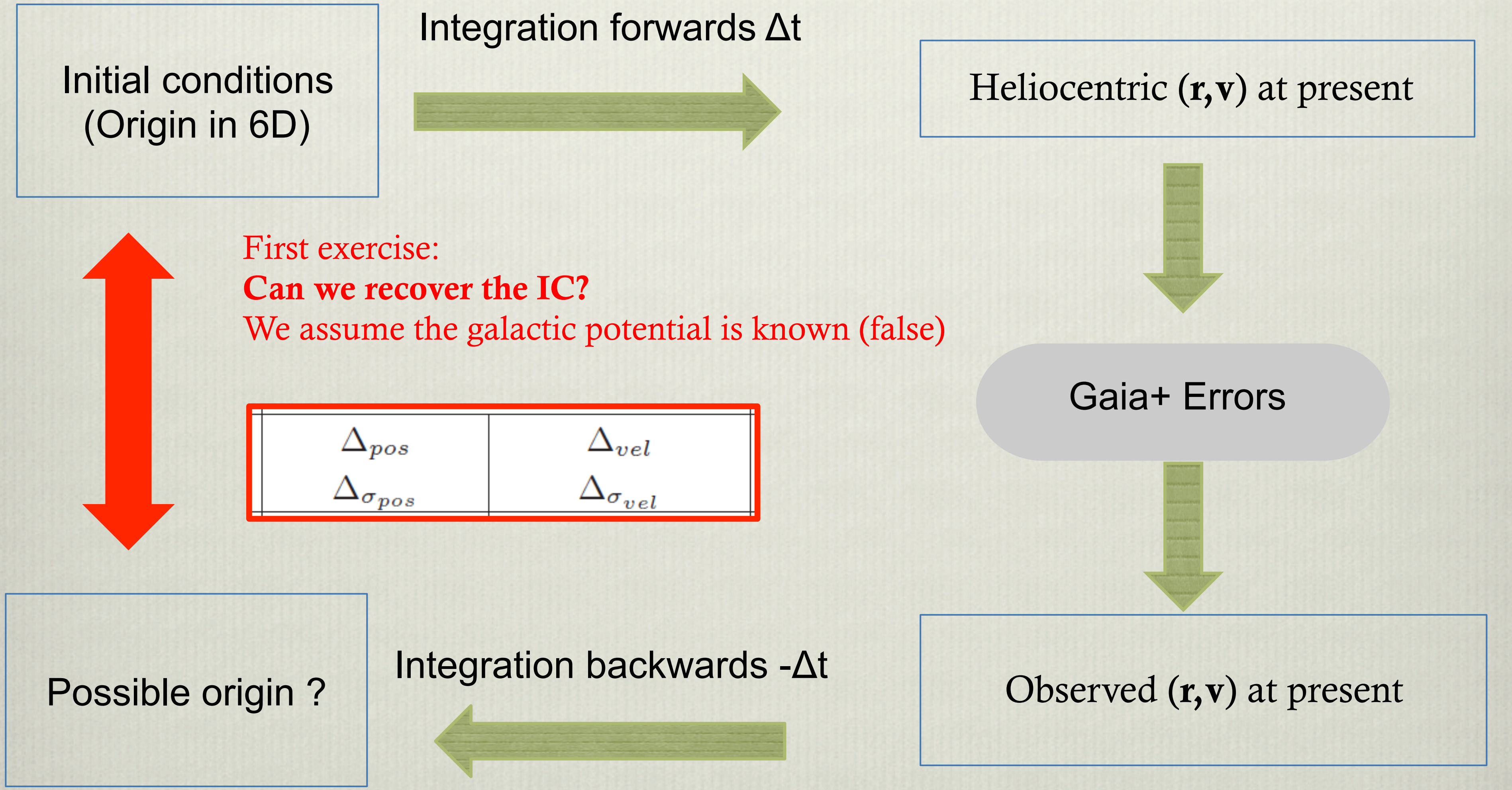
YLA at present accuracy in radial velocities



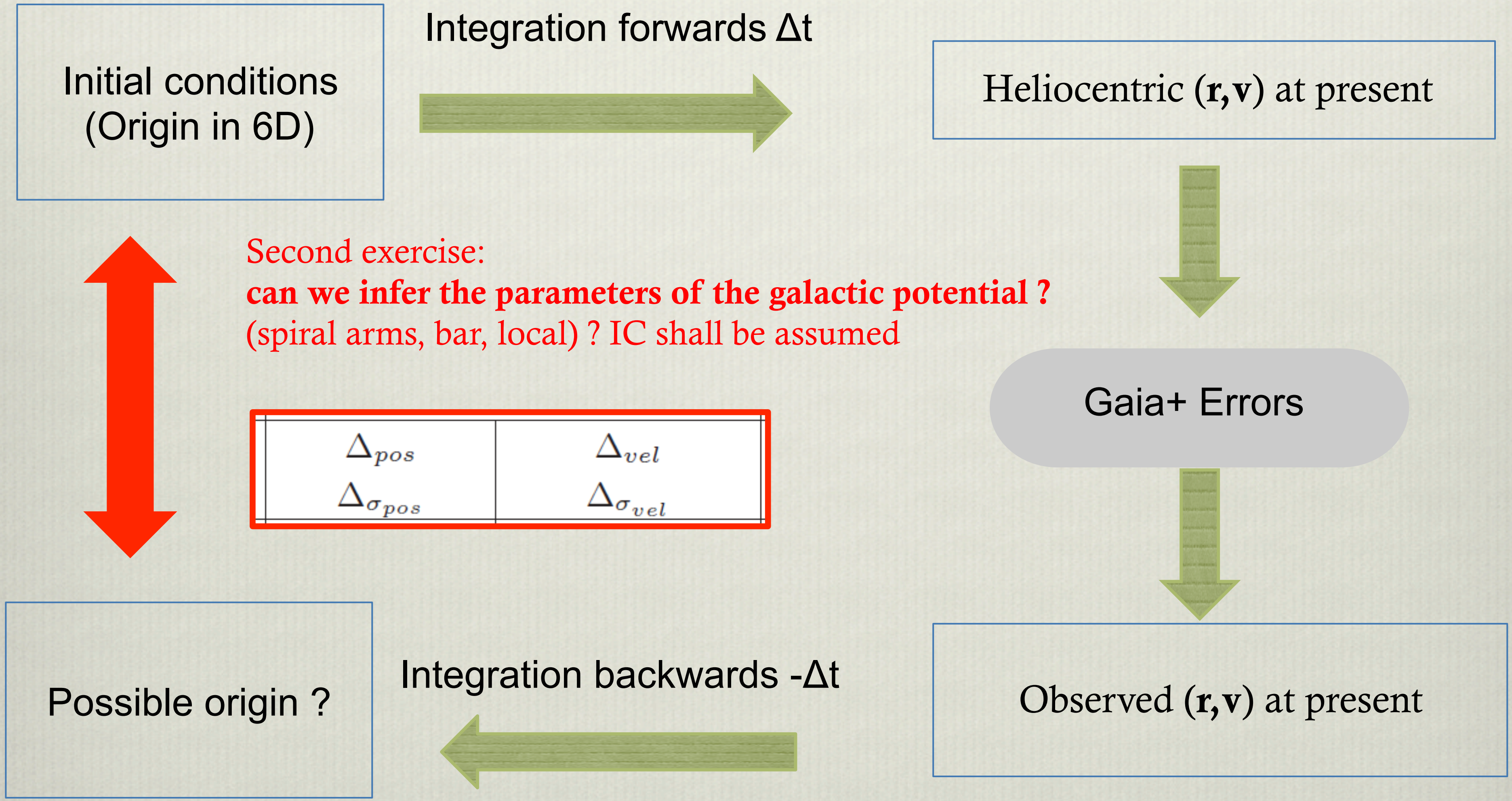
Simulating YLA evolution



Simulating YLA evolution



Simulating YLA evolution

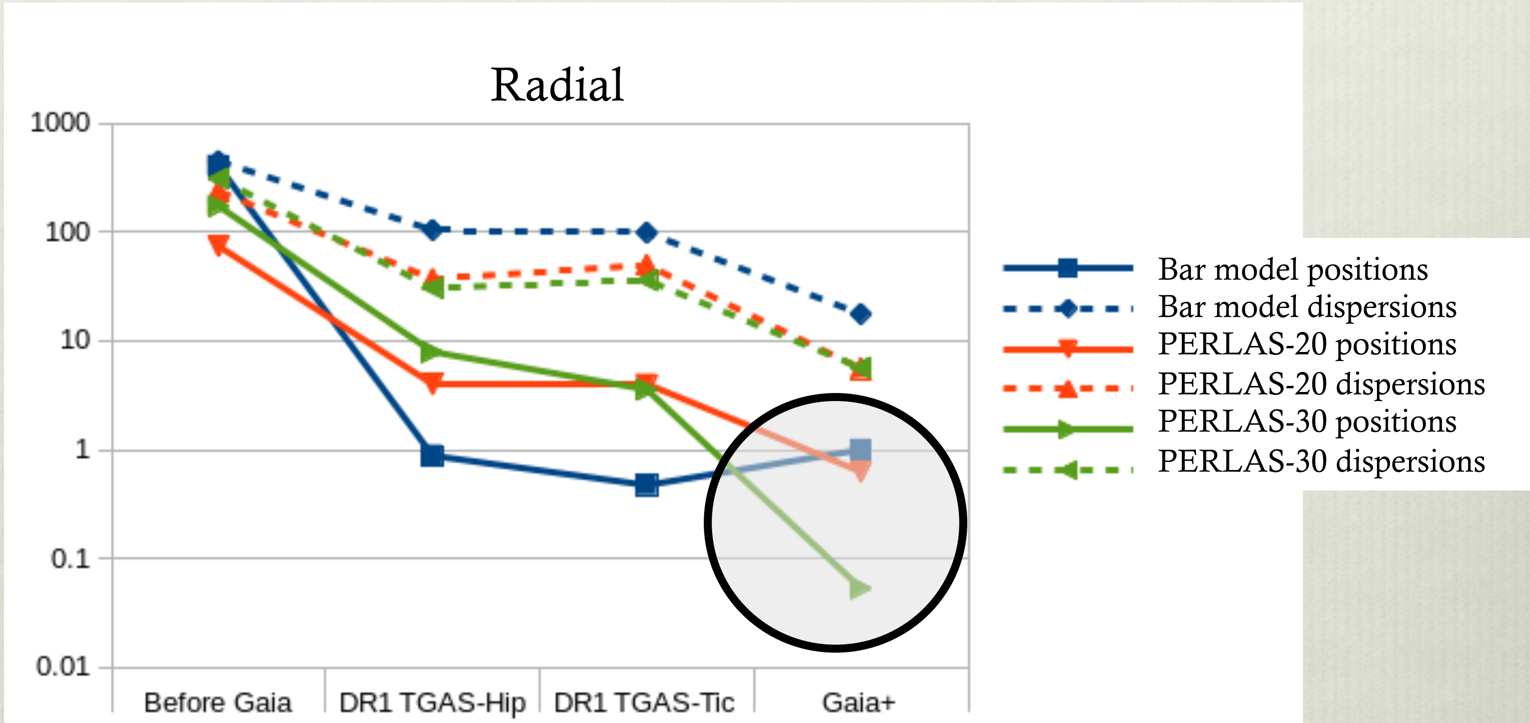


Second exercise:
can we infer the parameters of the galactic potential ?
(spiral arms, bar, local) ? IC shall be assumed

Δ_{pos}	Δ_{vel}
$\Delta_{\sigma_{pos}}$	$\Delta_{\sigma_{vel}}$

Accuracy in the derivation of the "at birth" position (50 Myr old)

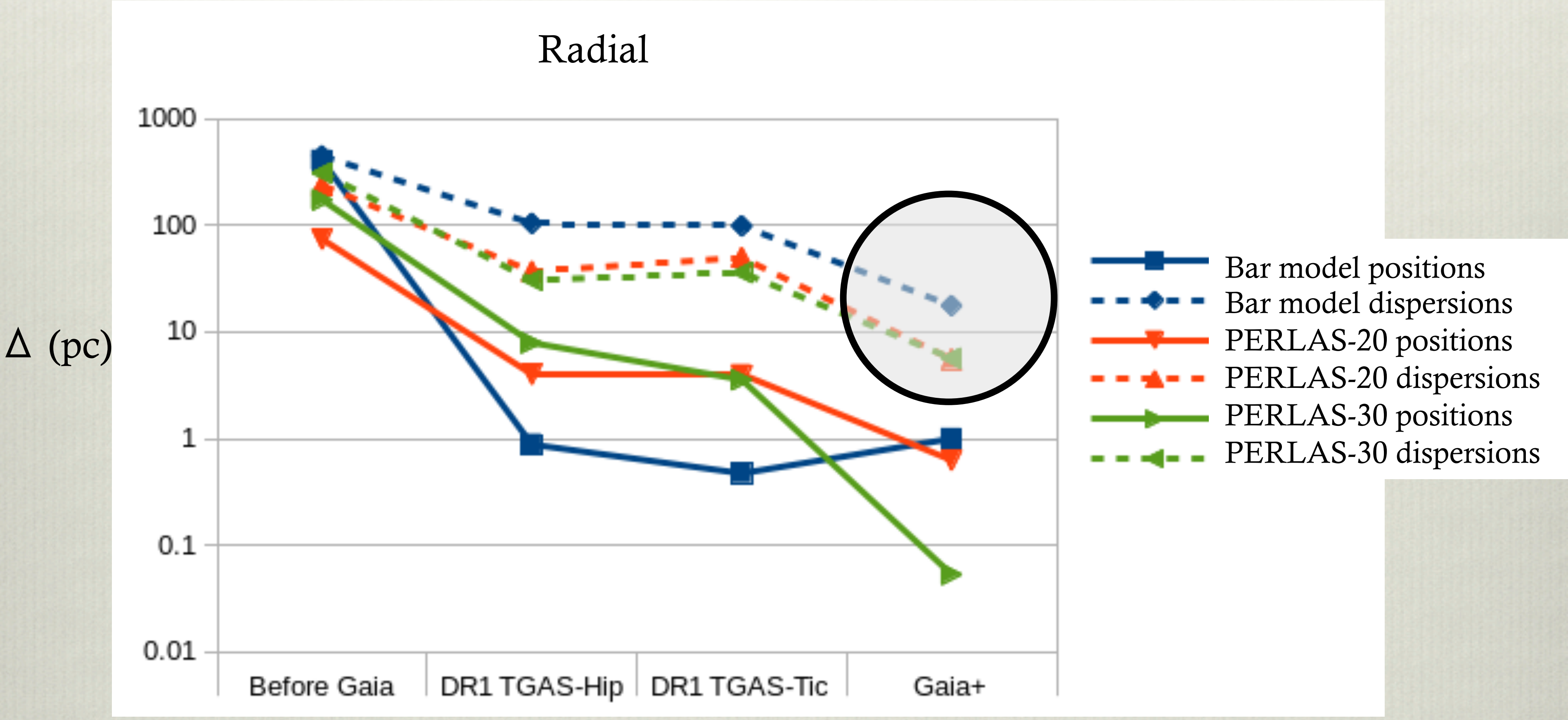
Δ (pc)



Before Gaia: ~1 kpc
DR1-Hip: ~ 20-40 pc
DR1-Tyc: ~ 20-40 pc
Gaia+: < 5 pc

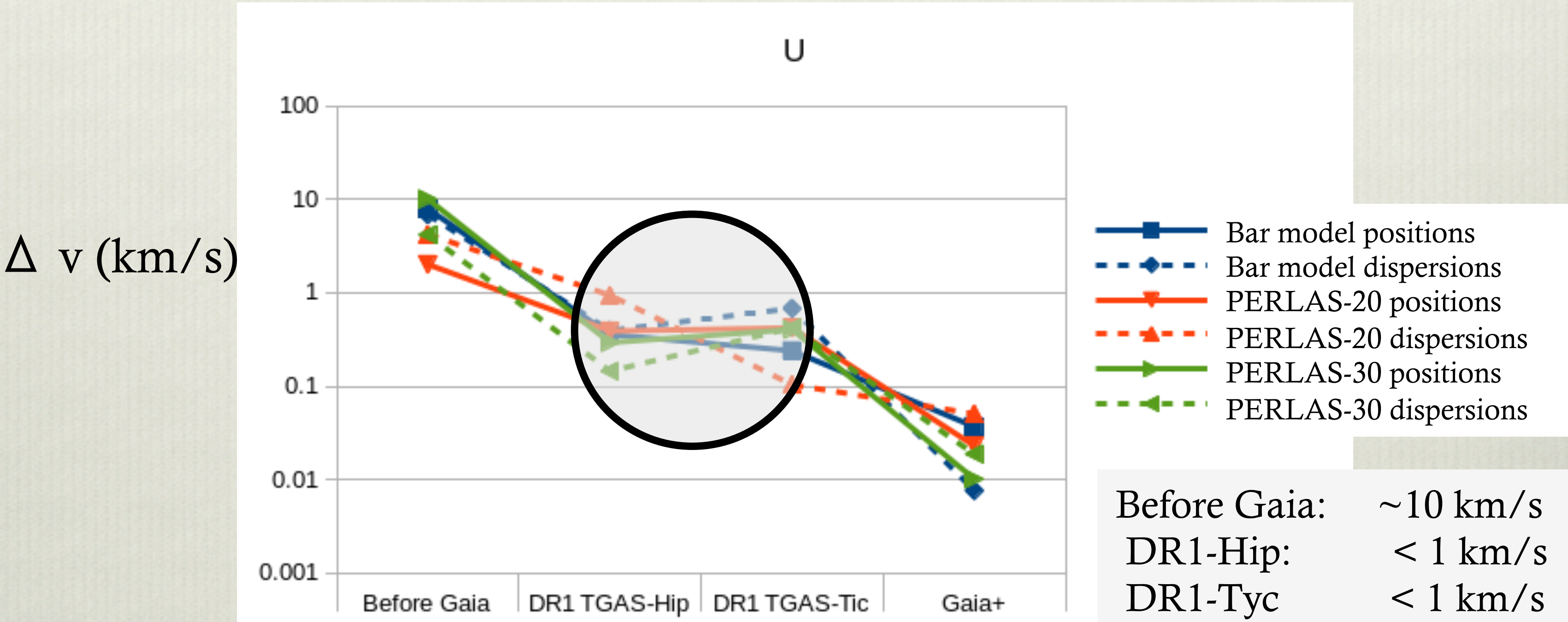
The increase in N compensates lower accuracy
(unrealistic, potential not know)

Accuracy in the derivation of the dynamical age for a YLA



The YLA is born with no dispersion in position
After 50 Myr, the simulated age, the dispersion is < 10 pc only for Gaia+
Dynamical ages shall wait for end-of-mission data

Accuracy in the derivation of the at birth velocities



Before Gaia:	~10 km/s
DR1-Hip:	< 1 km/s
DR1-Tyc	< 1 km/s
Gaia+:	**< 1 km/s**

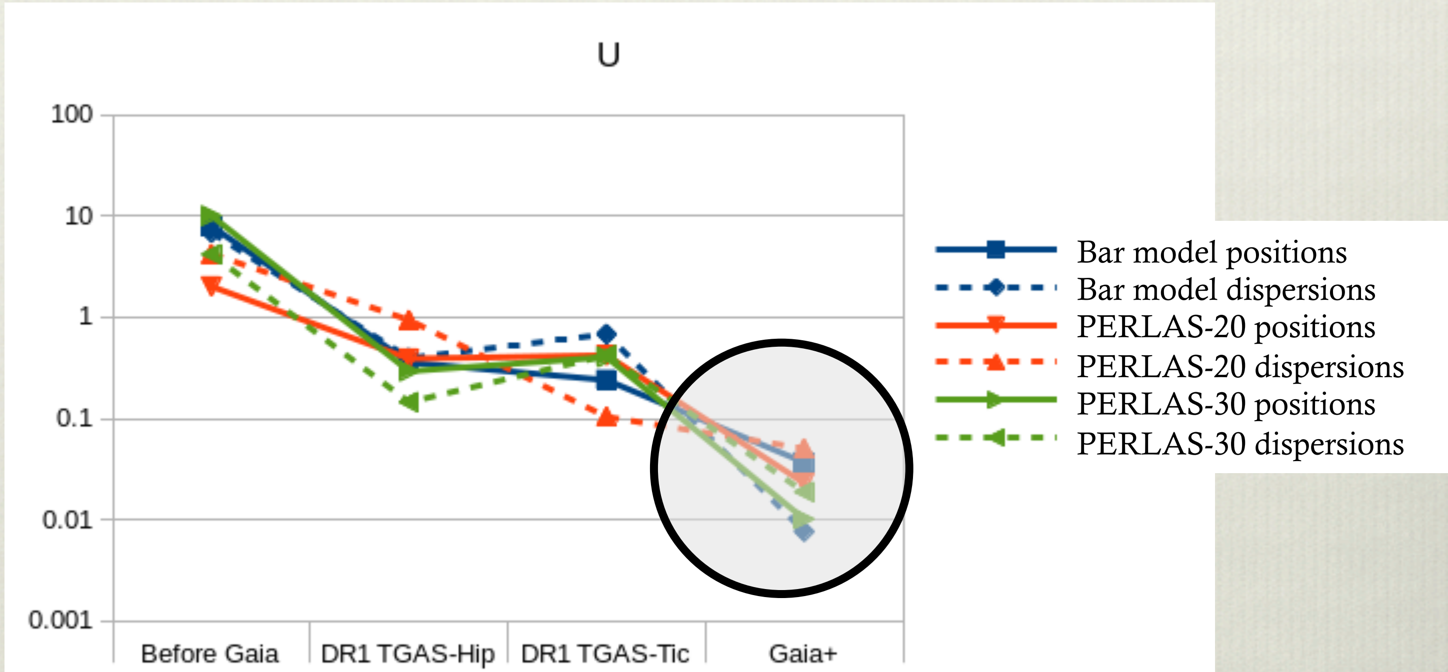
Components of the LSR velocity at birth can be recovered with DR1

- Star formation models can be tested

The simulated YLA is born with 2km/s velocity dispersion (dotted lines):

- velocity dispersion at birth can be recovered in DR1

Constraints on the galactic potential from YLA



Δ v (km/s)

With Gaia+ error propagation is very small:

- kinematic signatures due to the potential can be checked

DR1-Tyc data can be used to interpret dispersion ratios in terms of the potential

To do:

1. Strategy to select "young objects" from TGAS candidate to belong to YLAs
   VO cross-match: XMM, spectra (Hα, Li), T Tauri, IR Ca Triplet, …

2. A Gaia Challenge for DR1: Detection of new members from astrometry only
   Re-do full sky analysis using clustering multivariate techniques
   e.g.: work on the (H- reduced proper motion, color) plane (no RV)

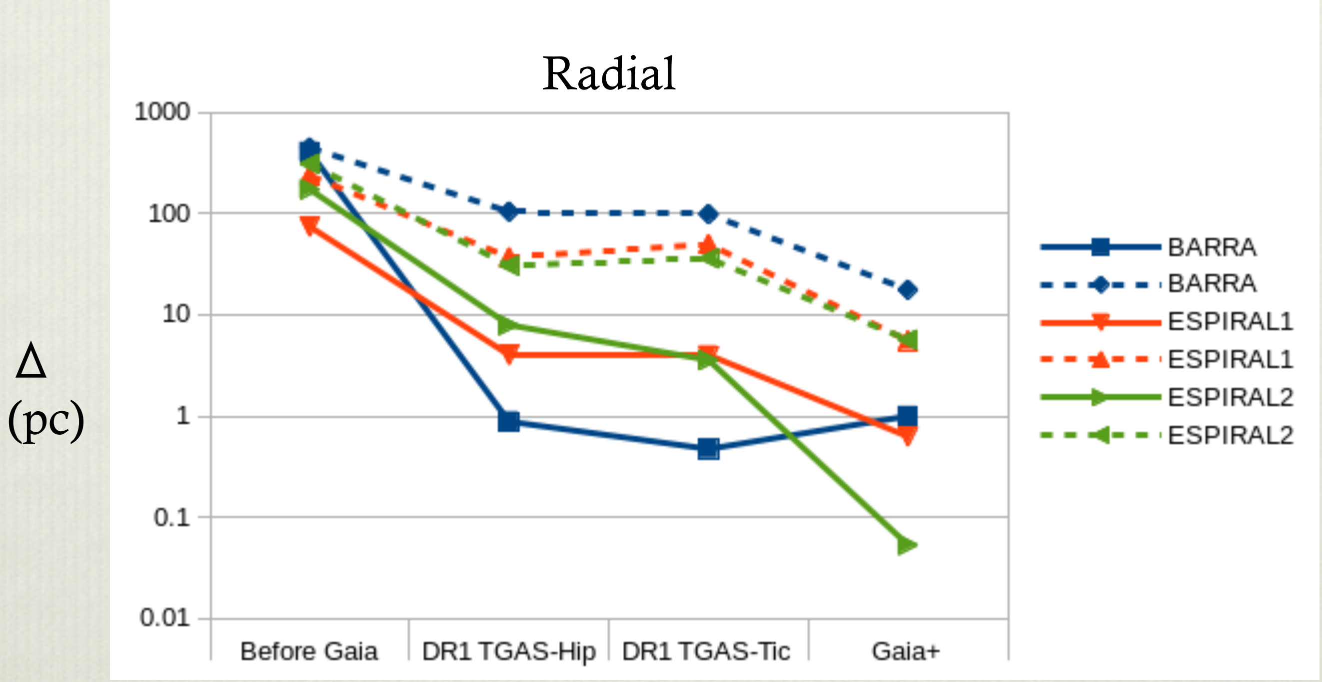
3. Compile Radial Velocity data for TGAS sources (through VO)

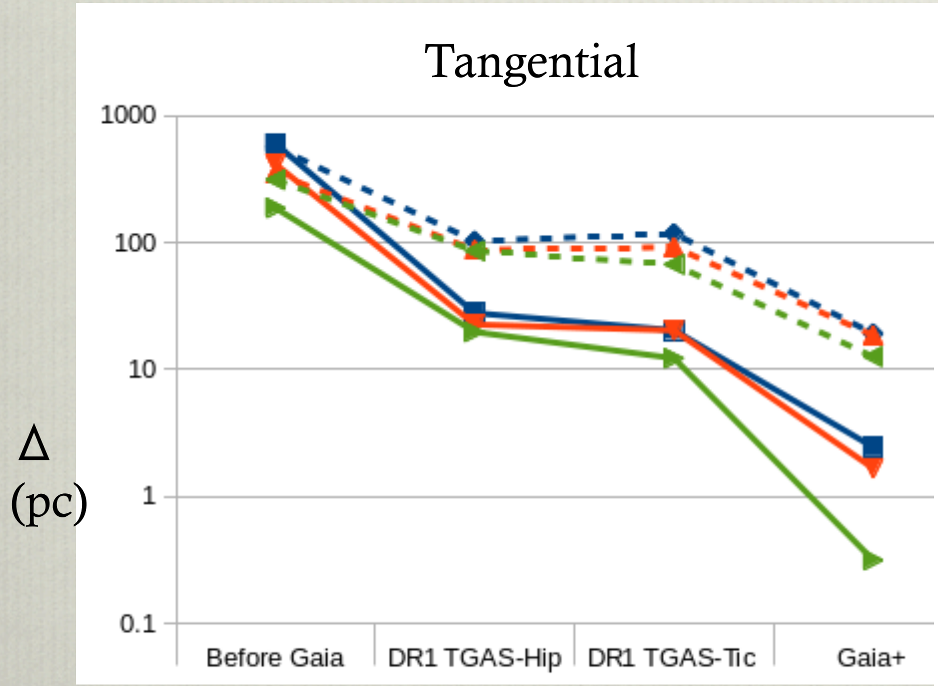
4. ….

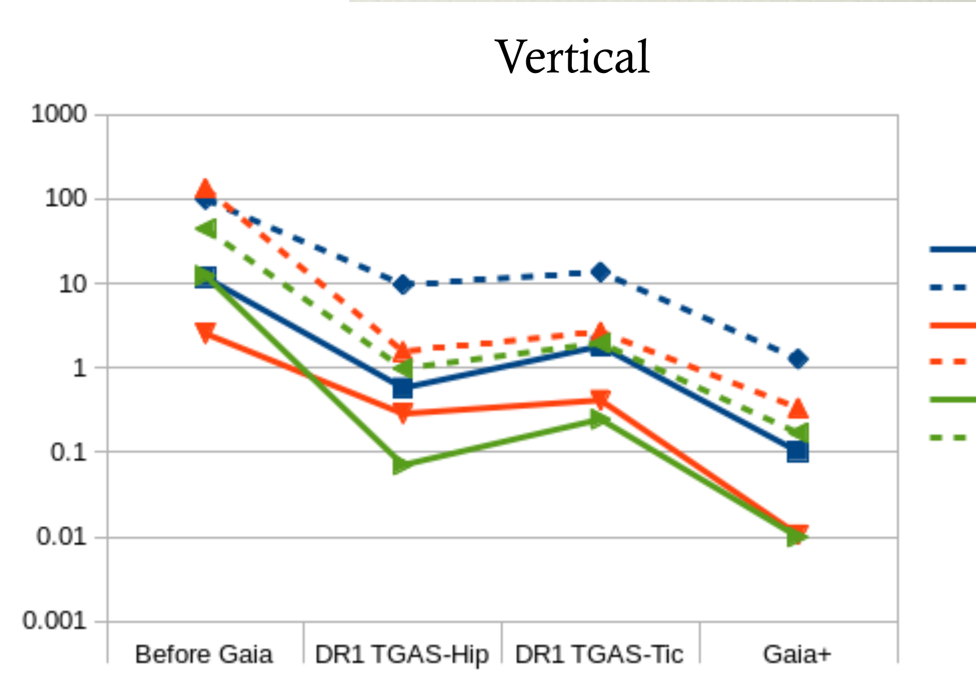
Catalogues	Sample name	Number of sources	B-V	Torres
Tycho-2 + 1RXS		6.407	4.610 (72%)	1664 (36%)
Tycho-2 + 3XMM		7.145	3.469 (49%)	82 (2%)
Tycho-2 + RAVE		287.315	217.491 (76%)	481 (0.2%)

TABLE IV: Review of the cross-match.

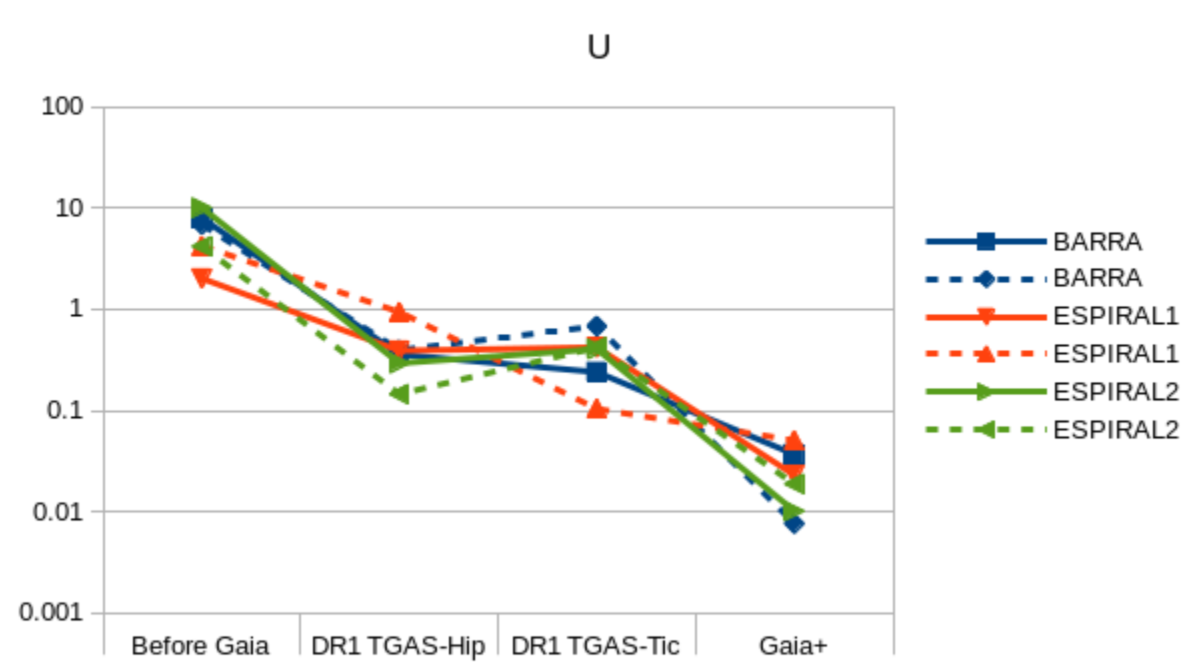
End

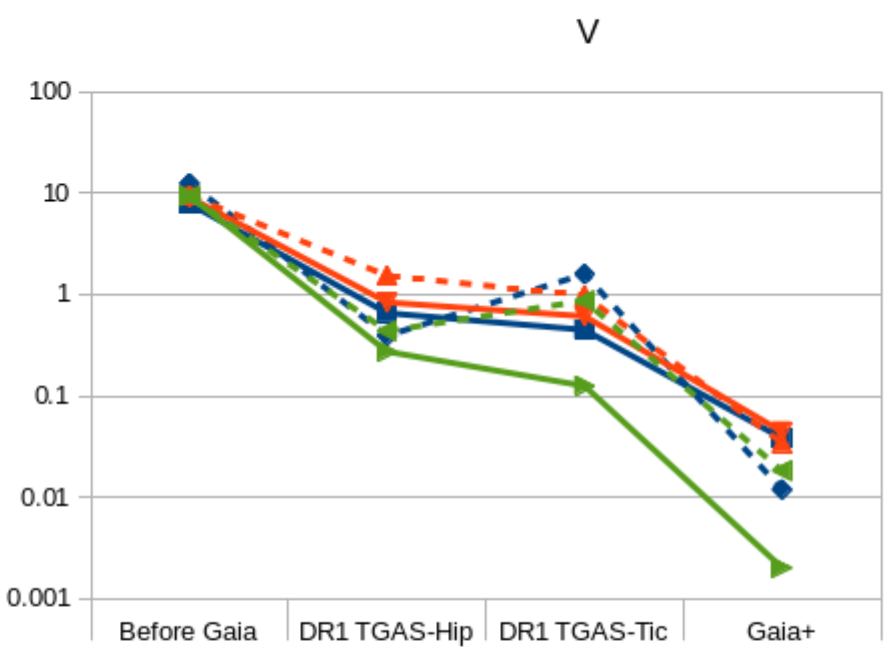

Radial
Δ (pc)
1000
100
10
1
0.1
0.01
Before Gaia
DR1 TGAS-Hip
DR1 TGAS-Tic
Gaia+
BARRA
BARRA
ESPIRAL1
ESPIRAL1
ESPIRAL2
ESPIRAL2

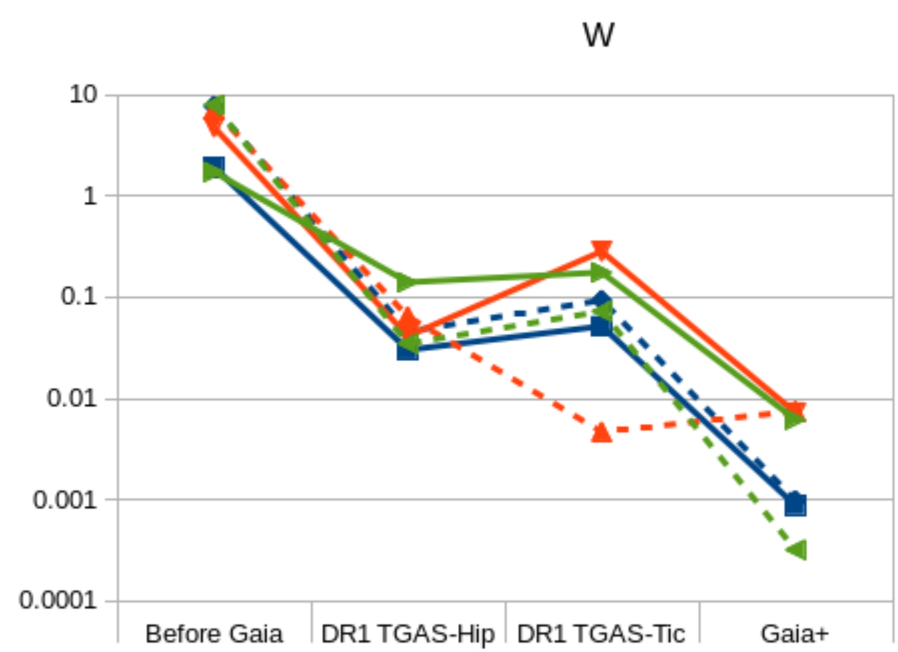

Tangential
Δ (pc)
1000
100
10
1
0.1
Before Gaia
DR1 TGAS-Hip
DR1 TGAS-Tic
Gaia+


Vertical
1000
100
10
1
0.1
0.01
0.001
Before Gaia
DR1 TGAS-Hip
DR1 TGAS-Tic
Gaia+

Δ v (km/s)


U
100
10
1
0.1
0.01
0.001
Before Gaia
DR1 TGAS-Hip
DR1 TGAS-Tic
Gaia+
BARRA
BARRA
ESPIRAL1
ESPIRAL1
ESPIRAL2
ESPIRAL2


V
100
10
1
0.1
0.01
0.001
Before Gaia
DR1 TGAS-Hip
DR1 TGAS-Tic
Gaia+


W
10
1
0.1
0.01
0.001
0.0001
Before Gaia
DR1 TGAS-Hip
DR1 TGAS-Tic
Gaia+

	BAR model		PERLAS model ($\Omega = 20$)		PERLAS model ($\Omega = 30$)	
	Δ_{pos} $\Delta_{\sigma_{pos}}$	Δ_{vel} $\Delta_{\sigma_{vel}}$	Δ_{pos} $\Delta_{\sigma_{pos}}$	Δ_{vel} $\Delta_{\sigma_{vel}}$	Δ_{pos} $\Delta_{\sigma_{pos}}$	Δ_{vel} $\Delta_{\sigma_{vel}}$
Before Gaia	(585.,406.,11.) (565.,447.,99.)	(7.34,7.85,1.93) (6.88,12.45,7.72)	(415.,78.,2.) (350.,237.,133.)	(2.,7.5,4.75) (4.2,9.4,7.1)	(188.,174.,12.5) (8.59,2.51,4.26)	(10.,9.4,1.7) (4.1,9.2,7.9)
DR1 TGAS-Hip	(28.,1.,0.6) (103.,104.,10.)	(0.36,0.70,0.02) (0.4,0.4,0.05)	(22.,4.,0.04) (87.,37.,1.)	(0.4,0.46,0.04) (0.95,1.5,0.1)	(18.,8.,0.1) (86.,31.,0.0)	(0.3,0.3,0.1) (0.2,0.5,0.1)
DR1 TGAS-Tyc	(21.,0.4,0.0) (118.,99.,14.)	(0.23,0.4,0.05) (0.68,1.6,0.1)	(21.,4.,0.5) (92.,50.,3.)	(0.43,0.6,0.3) (0.1,1.,0.0)	(11.,4.,0.5) (67.,36.,2.)	(0.5,0.2,0.1) (0.4,0.9,0.5)
Gaia+	(2.,0.6,0.1) (19.,18.,1.)	(0.03,0.1,0.0) (0.0,0.01,0.0)	(2.,0.4,0.1) (18.,5.,0.0)	(0.0,0.4,0.0) (0.05,0.03,0.0)	(0.3,0.0,0.0) (13.,5.,0.0)	(0.0,0.0,0.0) (0.01,0.02,0.0)