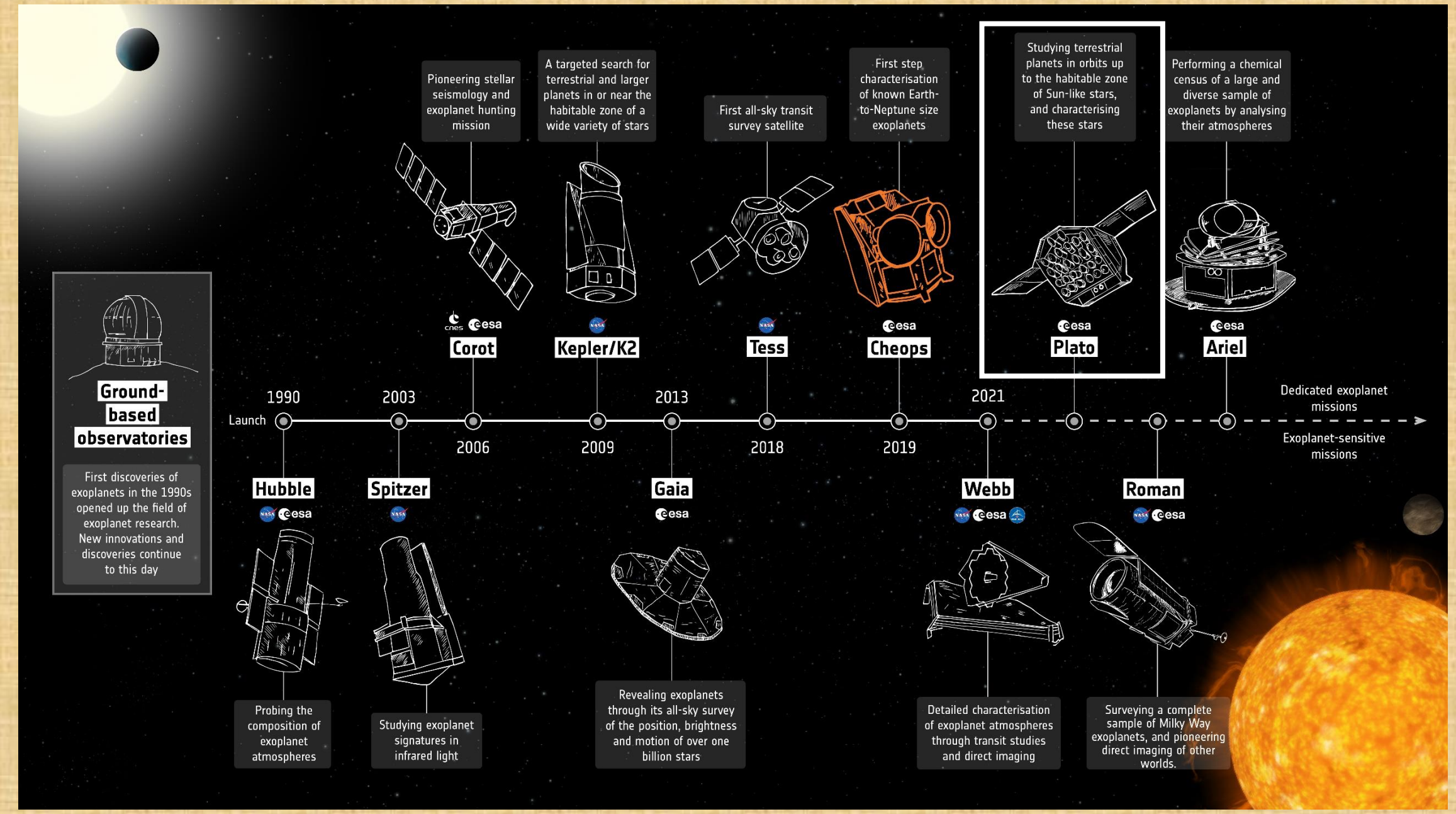
plato

LIÈGE université

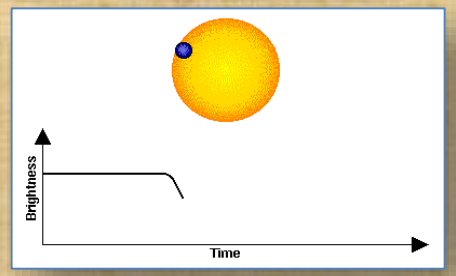
ISSP: link with PLATO


Ground-based observatories
First discoveries of exoplanets in the 1990s opened up the field of exoplanet research. New innovations and discoveries continue to this day
Launch
1990
2003
2006
2009
2013
2018
2019
2021
Dedicated exoplanet missions
Exoplanet-sensitive missions
Hubble
Probing the composition of exoplanet atmospheres
Spitzer
Studying exoplanet signatures in infrared light
Corot
Pioneering stellar seismology and exoplanet hunting mission
Kepler/K2
A targeted search for terrestrial and larger planets in or near the habitable zone of a wide variety of stars
Gaia
Revealing exoplanets through its all-sky survey of the position, brightness and motion of over one billion stars
Tess
First all-sky transit survey satellite
Cheops
First step characterisation of known Earth-to-Neptune size exoplanets
Webb
Detailed characterisation of exoplanet atmospheres through transit studies and direct imaging
Plato
Studying terrestrial planets in orbits up to the habitable zone of Sun-like stars, and characterising these stars
Roman
Surveying a complete sample of Milky Way exoplanets, and pioneering direct imaging of other worlds.
Ariel
Performing a chemical census of a large and diverse sample of exoplanets by analysing their atmospheres

PLATO in a nutshell

Prime mission goals:

- Detect a large number of extrasolar transiting planets, including **Earth-sized planets up to the habitable zone of solar-like stars;**
- Determine precise **planetary radii, masses**, hence **mean densities;**
- Investigate seismic activity in stars, enabling the precise characterisation of the planet-host star, including its **age.**



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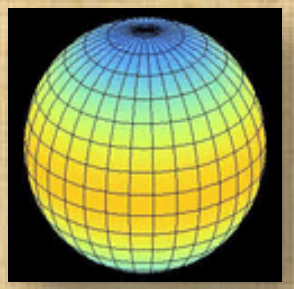

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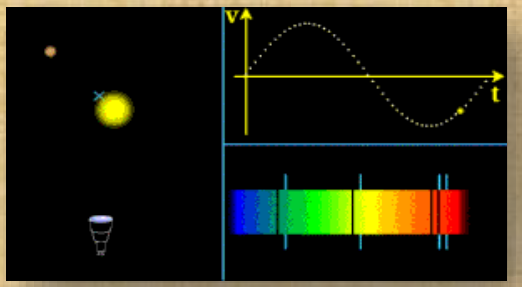
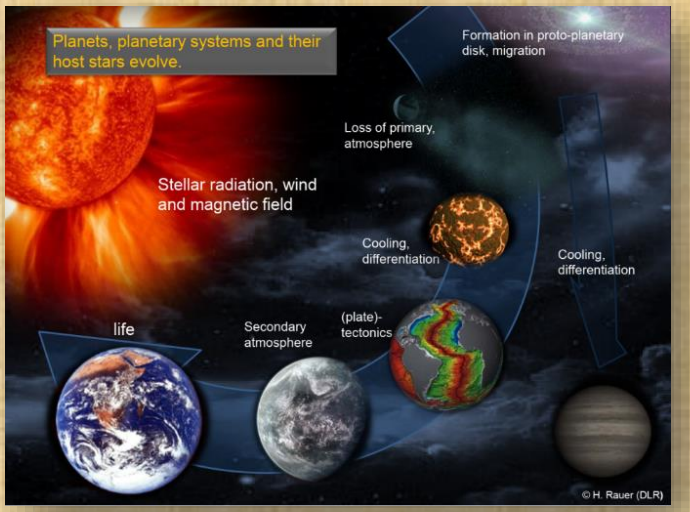




Transit detection	Asteroseismology	Ground-based observations
→ Planet/star radius ratio → Inclination	→ Stellar radius, mass → Stellar age	→ Planet mass

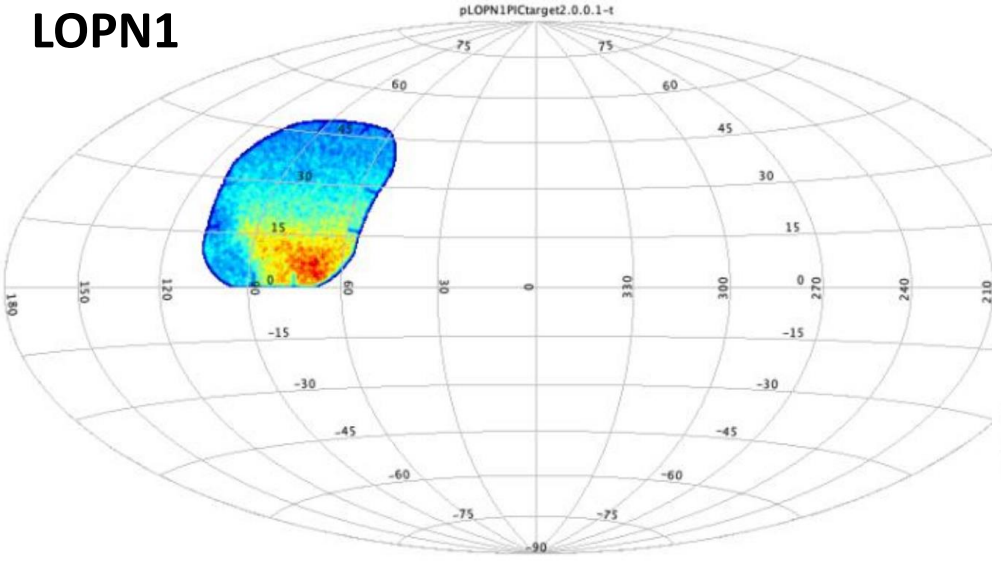
→ **Mean density**
Age

© Heike Rauer

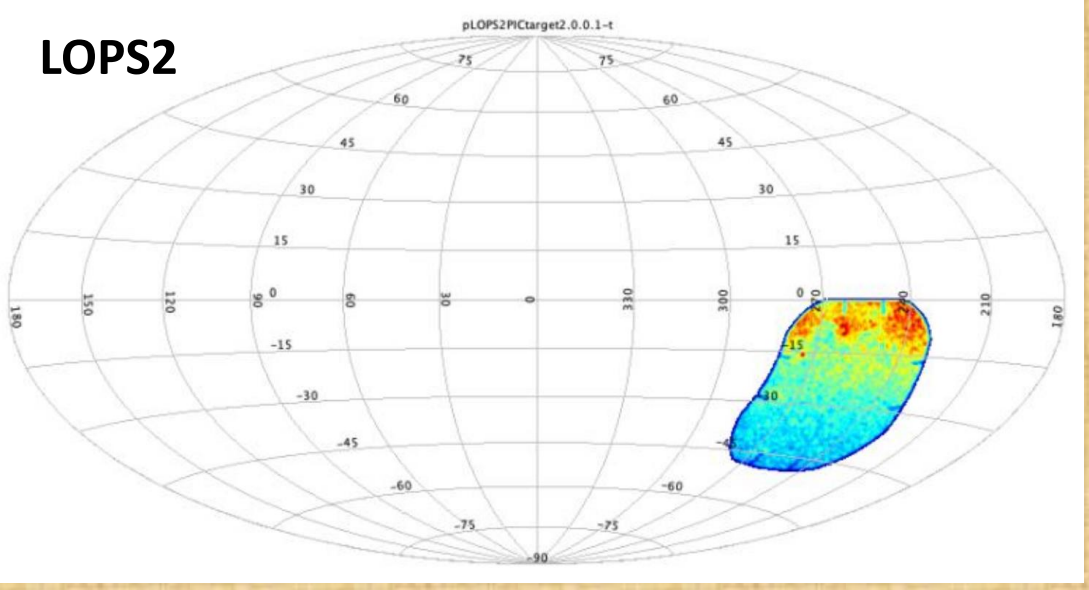
Long-pointing fields and stellar samples

Baseline for nominal mission: 2 long pointings lasting up to 3 years each. But alternative scenarios *do* exist. Final strategy to be decided at the latest 2 years before launch due Q4 2026. Current fields: LOPN1 (North) and LOPS2 (South) each covering ~2100 deg^2.

LOPN1

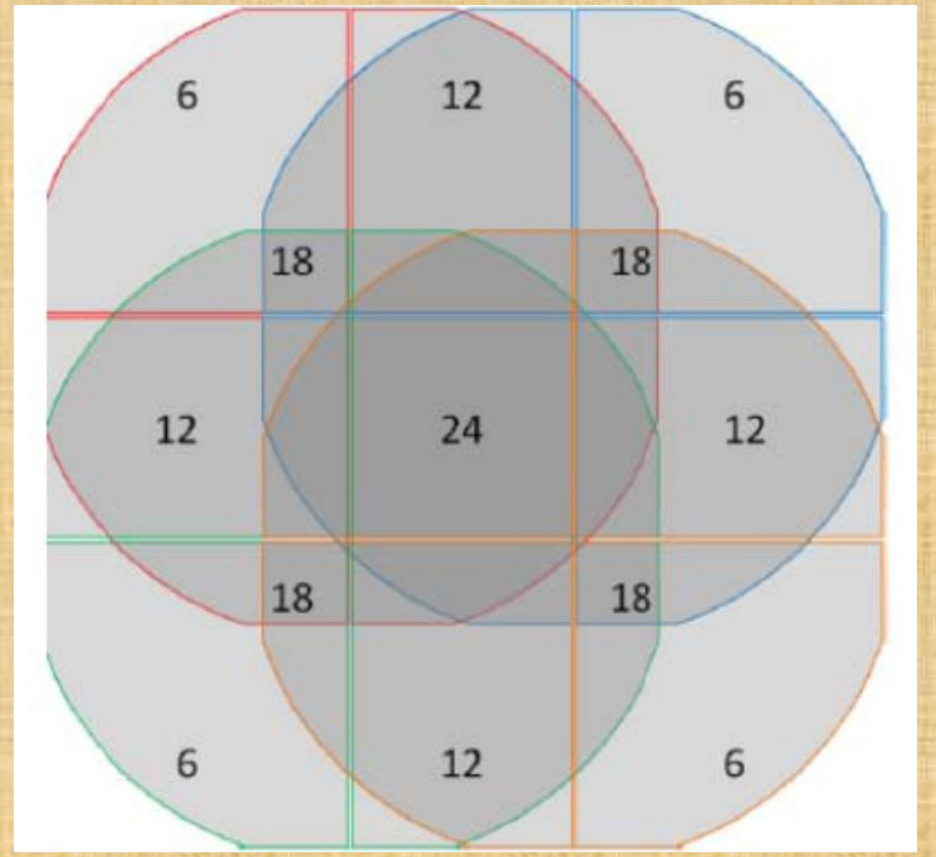


LOPS2



PLATO-SSDC-PDC-TN-006

OHB
GRADEL


6
12
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24
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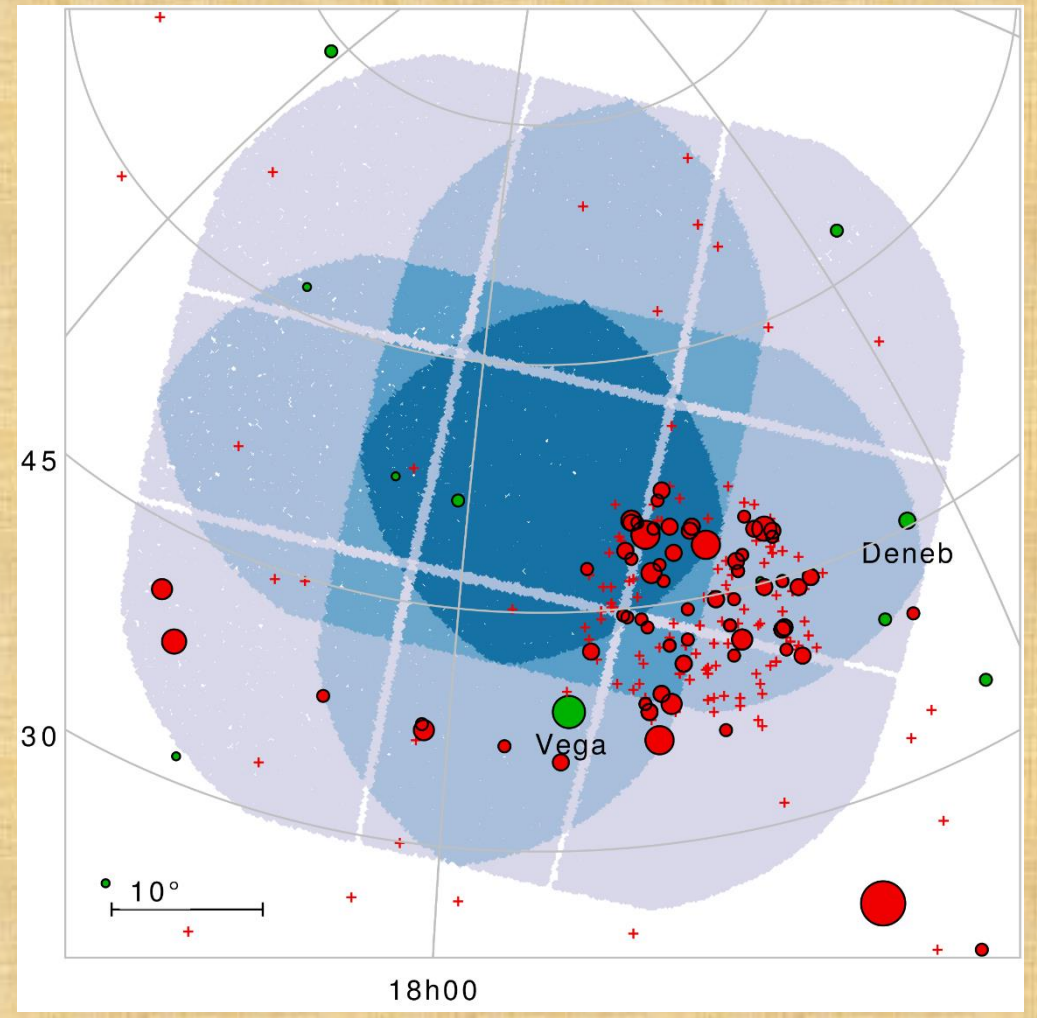
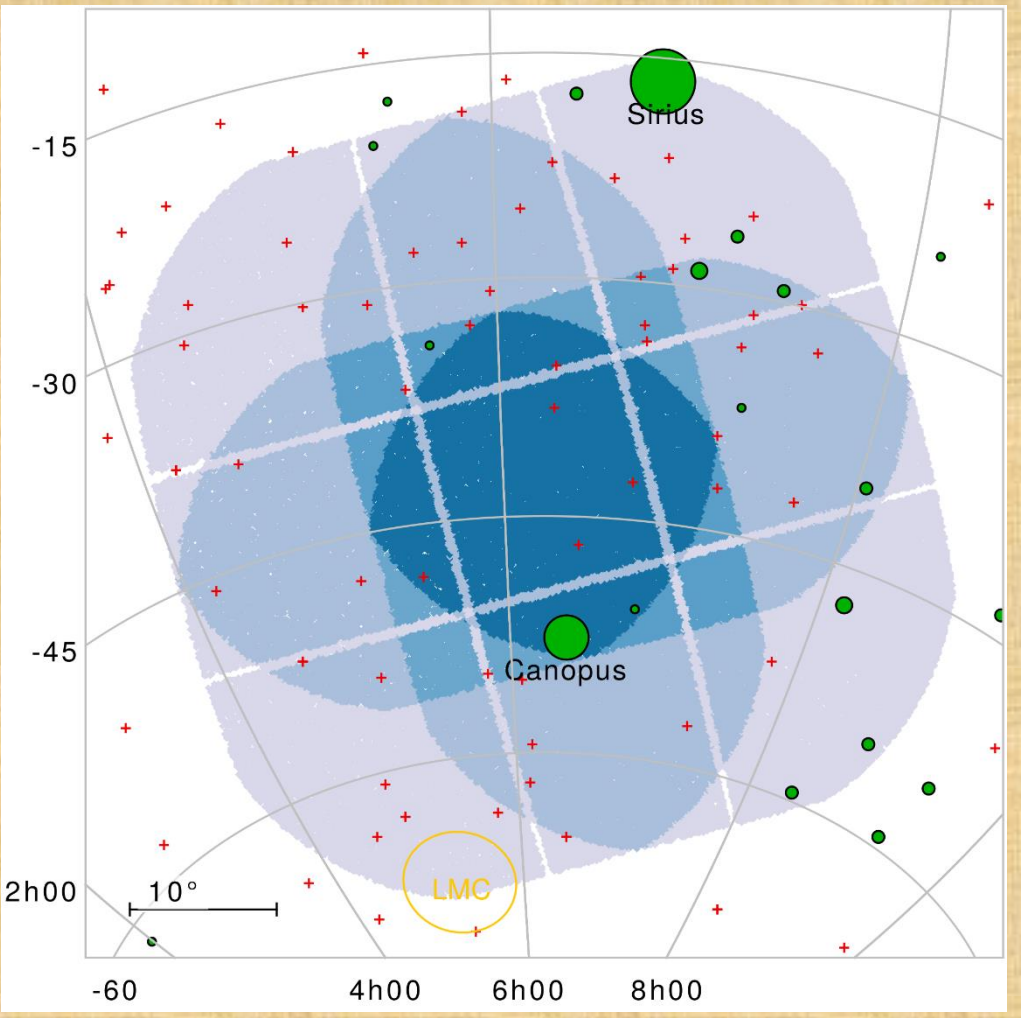
12
6

Bright stars ($V < 3$)
Known planet hosts

LOPN1

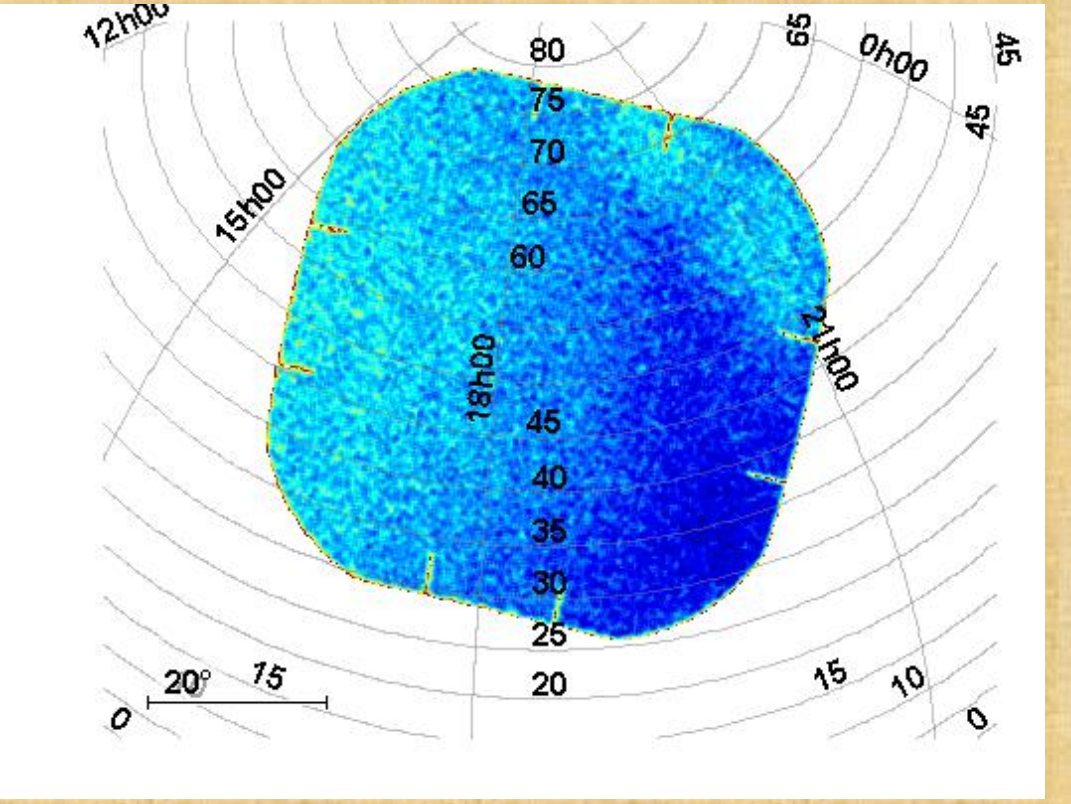


LOPS1 (LOPS2 is ~5° more to the South!)

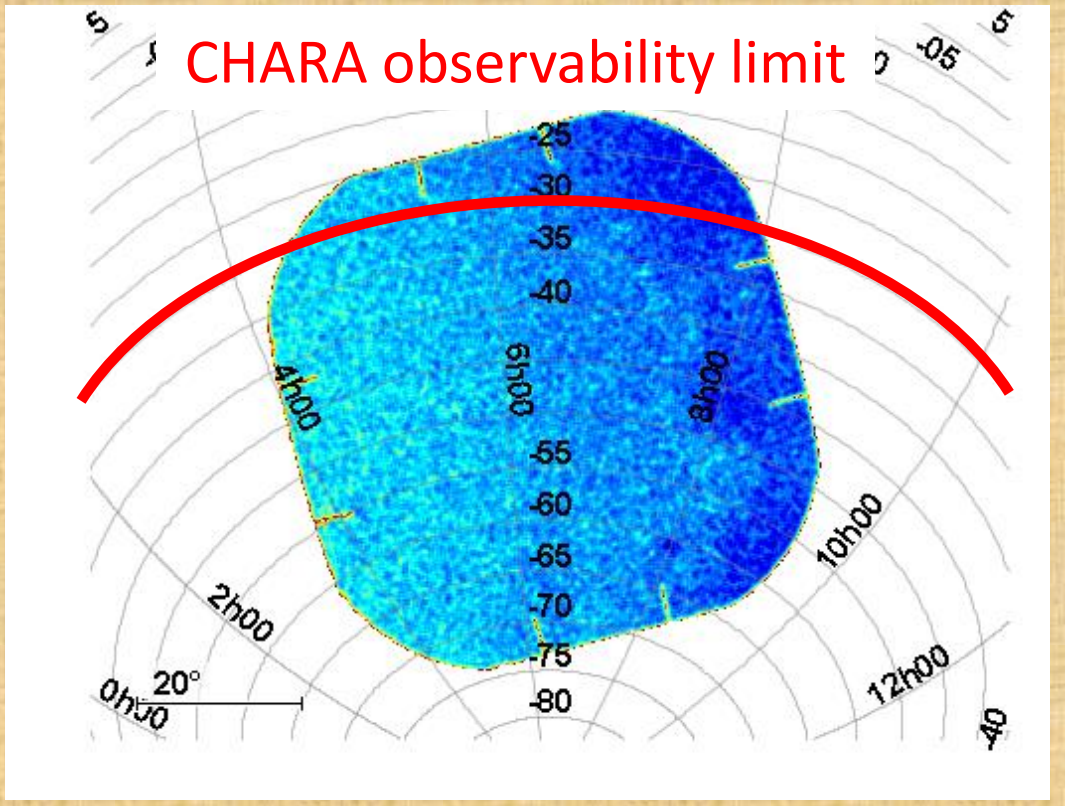


Nascimbeni+22

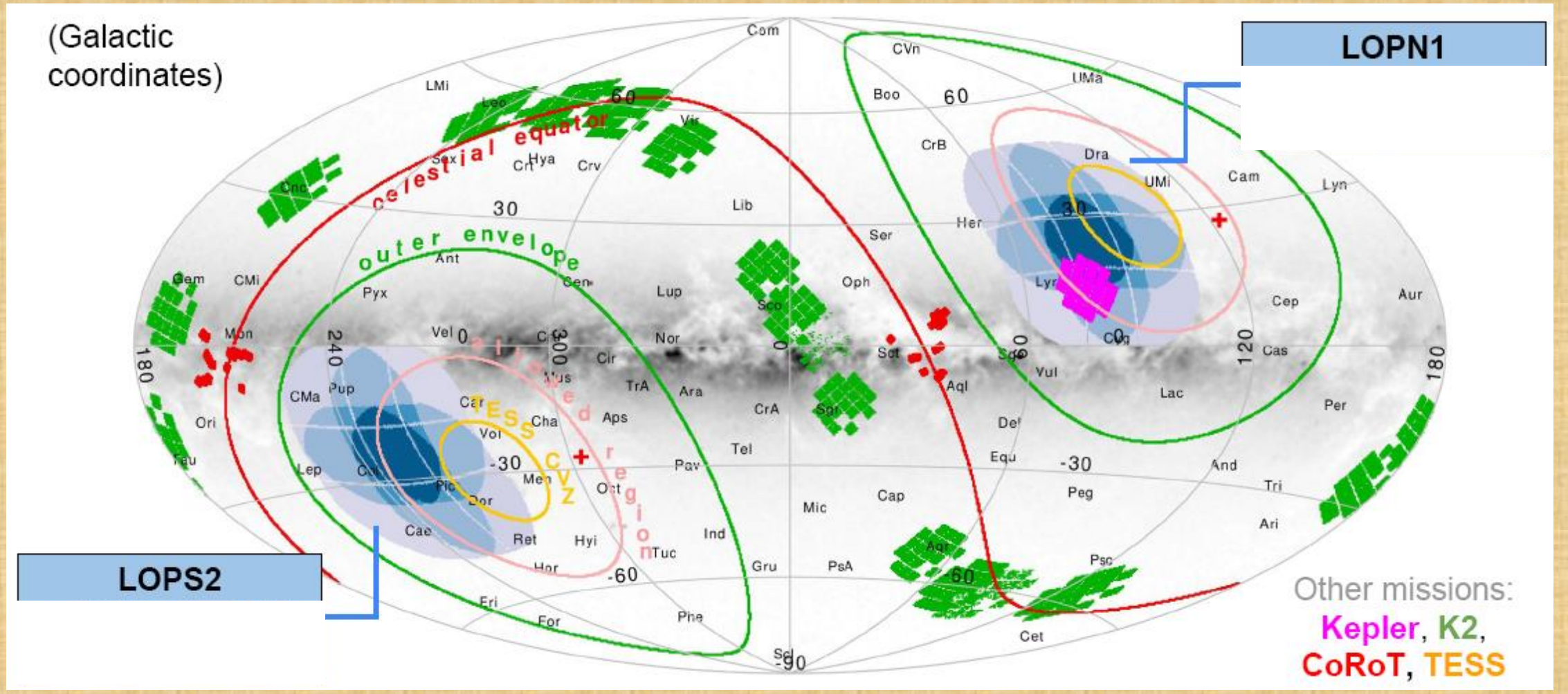
LOPN1



LOPS2



Based on PIC2.0.0 data



Talk Nascimbeni@PLATO Week #14

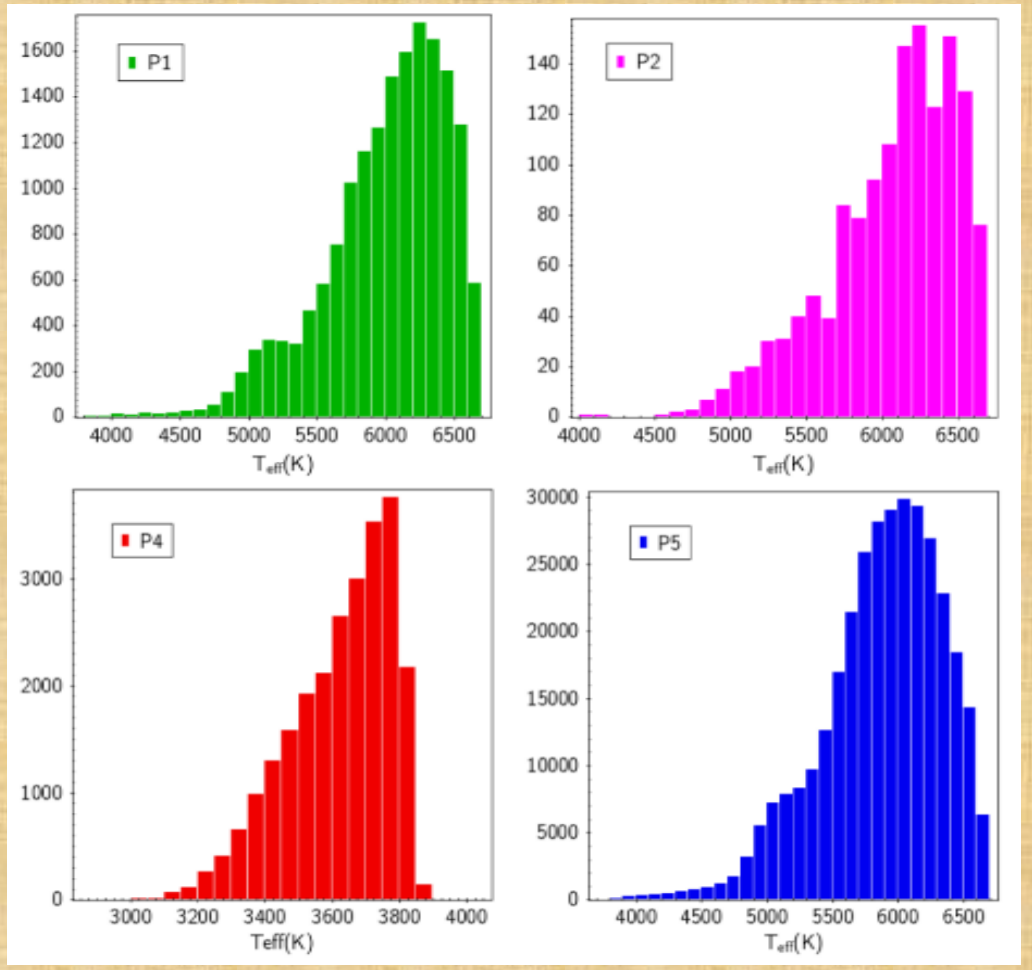
PLATO core programme samples

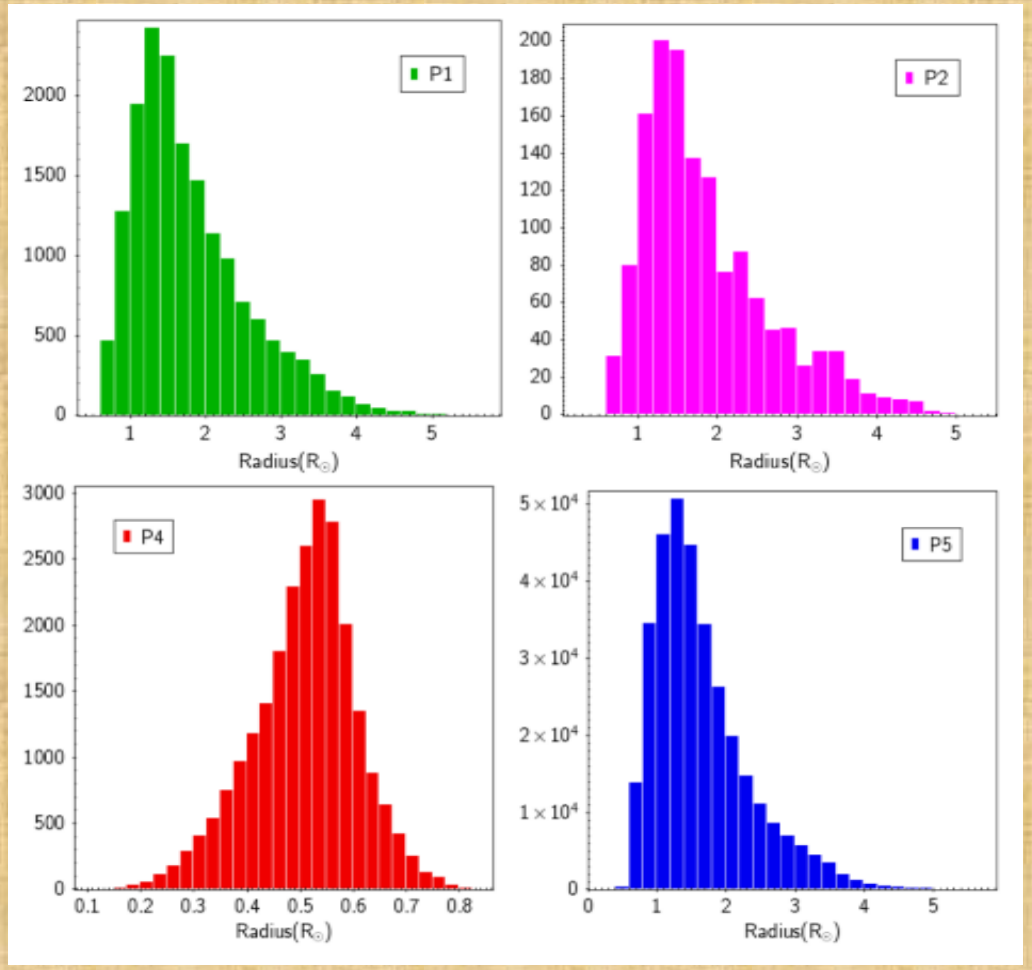
	P1 Detection of planets	**P2** Exo-planetary atmospheres	**P4** Earth-like planets in habitable zone	**P5** Statistical planet sample
N	> 15,000	> 1000	> 5000	> 245,000
Spectral type	F5-K7 IV-V	F5-K7 IV-V	K8-M V	F5-K7 IV-V
Magnitude	$V < 11$	$V < 8.2$	$V < 16$	$V < 13$
Seismology?	YES	YES	NO	For brightest
Interferometry	✗	✓	✗	✗
SBCRs	✓	✓	✓	✓

Availability of good IR photometry?

Relations fully reliable?

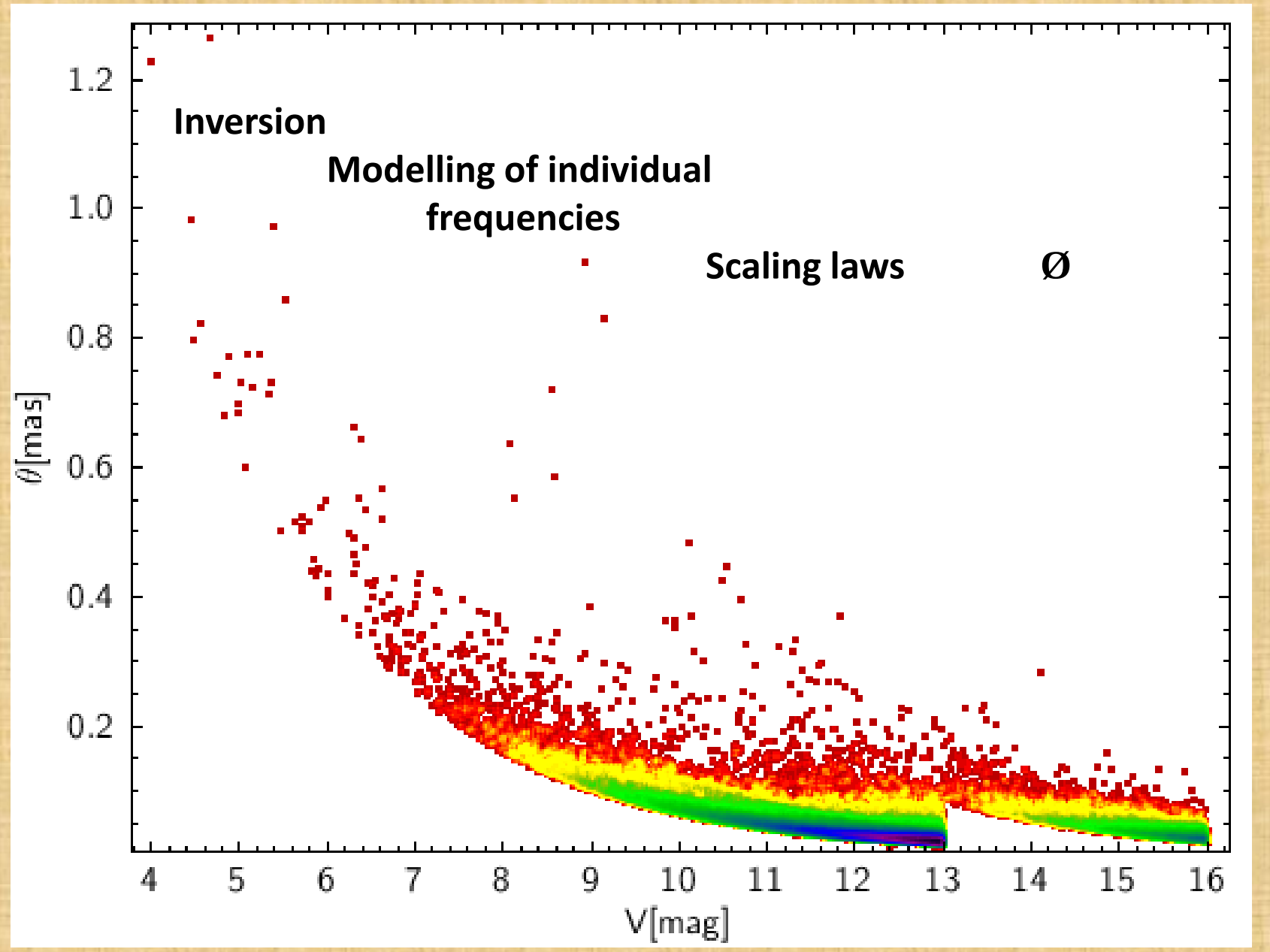
PLATO Input Catalogue (PIC) currently largely based on Gaia DR3 and assuming two long-pointing fields in each hemisphere.





PLATO-SCI-UPD-TN-0020

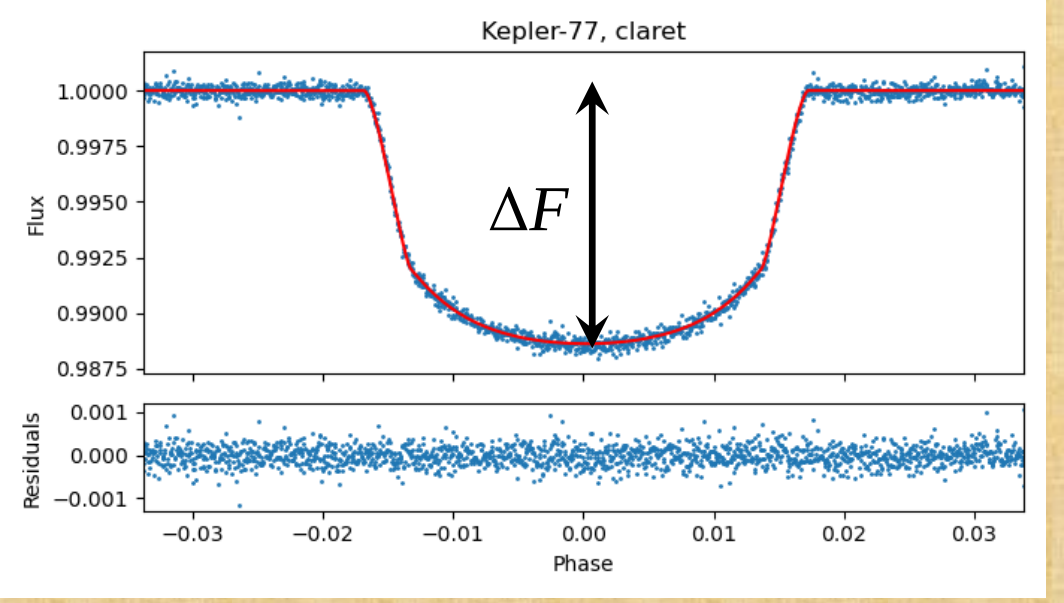
LOPN1 - density plot



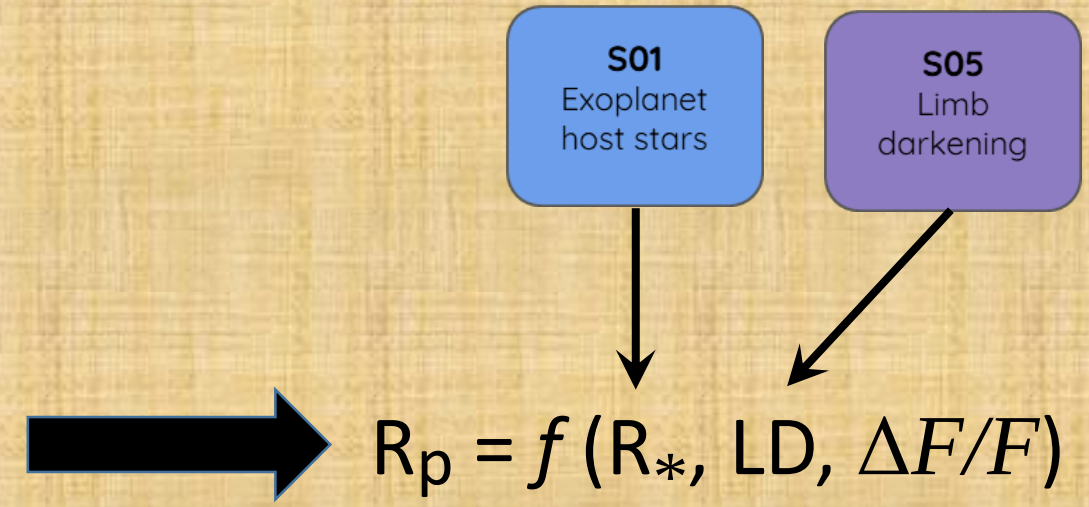
Scientific synergy ISSP-PLATO

R-SCI-L0-07 PLATO shall provide photometric data to determine the ratio of planetary-to-stellar radius with an accuracy of 2%, for a planet of the same size as the Earth orbiting a G0 V star of *V*=10 (goal *V*=11).

R-SCI-L0-55 PLATO shall provide photometric data to determine the radius of a G0 V star of *V*=10 (goal *V*=11) with a precision of 1–2%.

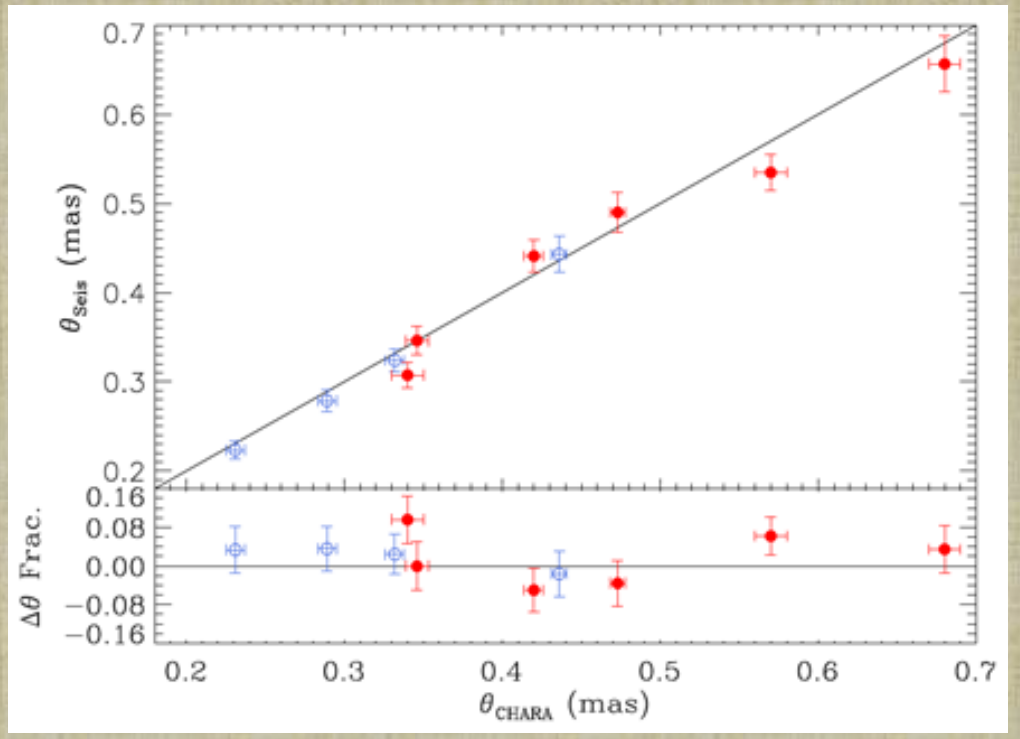


Maxted23

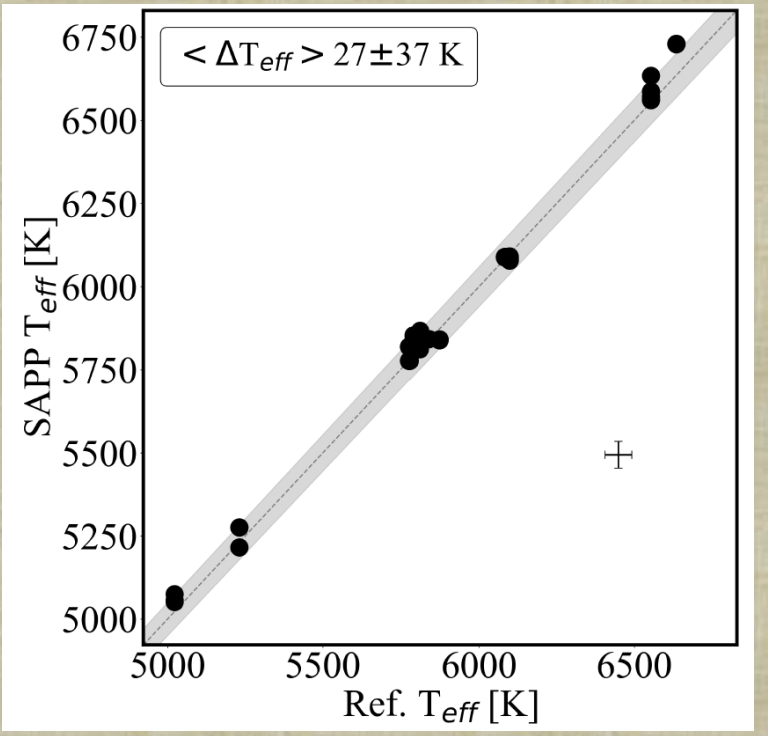


S02 - S03
Asteroseismic stars

- Interferometric follow up: improved stellar properties and constraints on physics
- Benchmarking of seismic radii
- Validation of pipeline for classical parameters (e.g. Teff scale)



Silva Aguirre+13



$$T_{\rm eff} = \left(\frac{4 f_{\rm bol}}{\sigma \theta^2}\right)^{1/4}$$

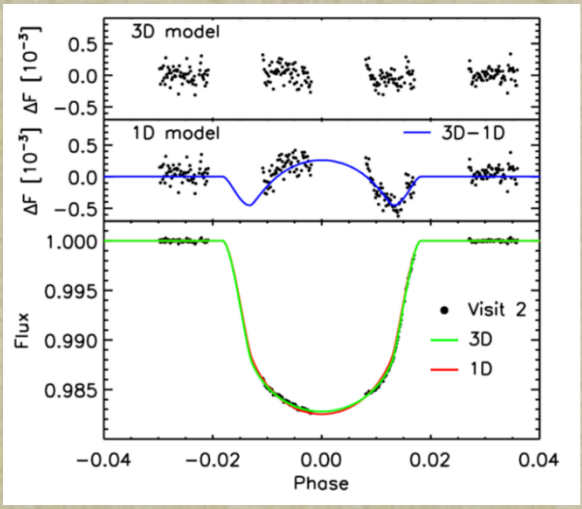
Gent+22

S04
Surface Brightness Color Relation

A large fraction of the PLATO samples (P4, faint end of P5) will not have a seismic radius!

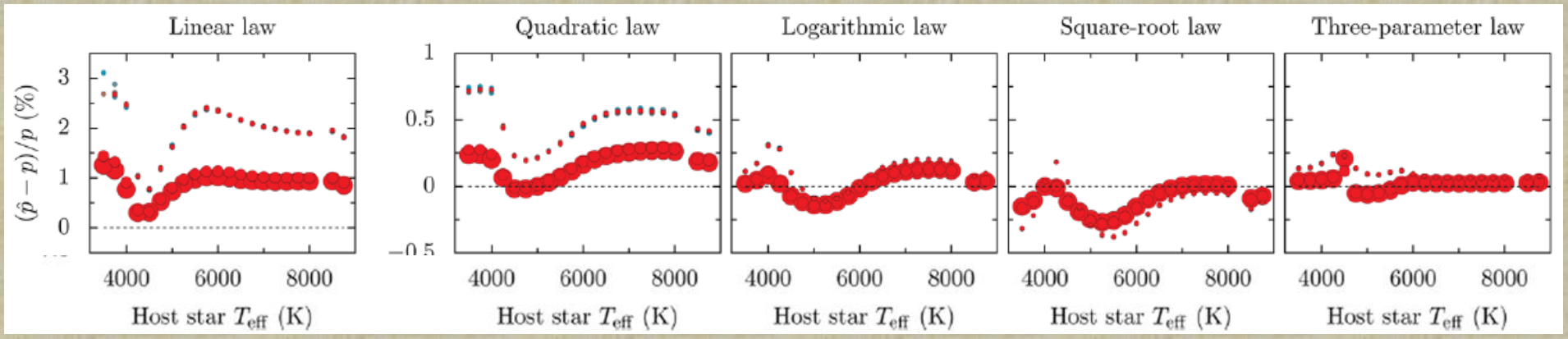
S05
Limb darkening

- Direct LD estimates for brightest POIs
- Test of model atmospheres/LD laws



Hayek+12

$p = R_p/R_*$, b: impact parameter



Espinoza & Jordán 16

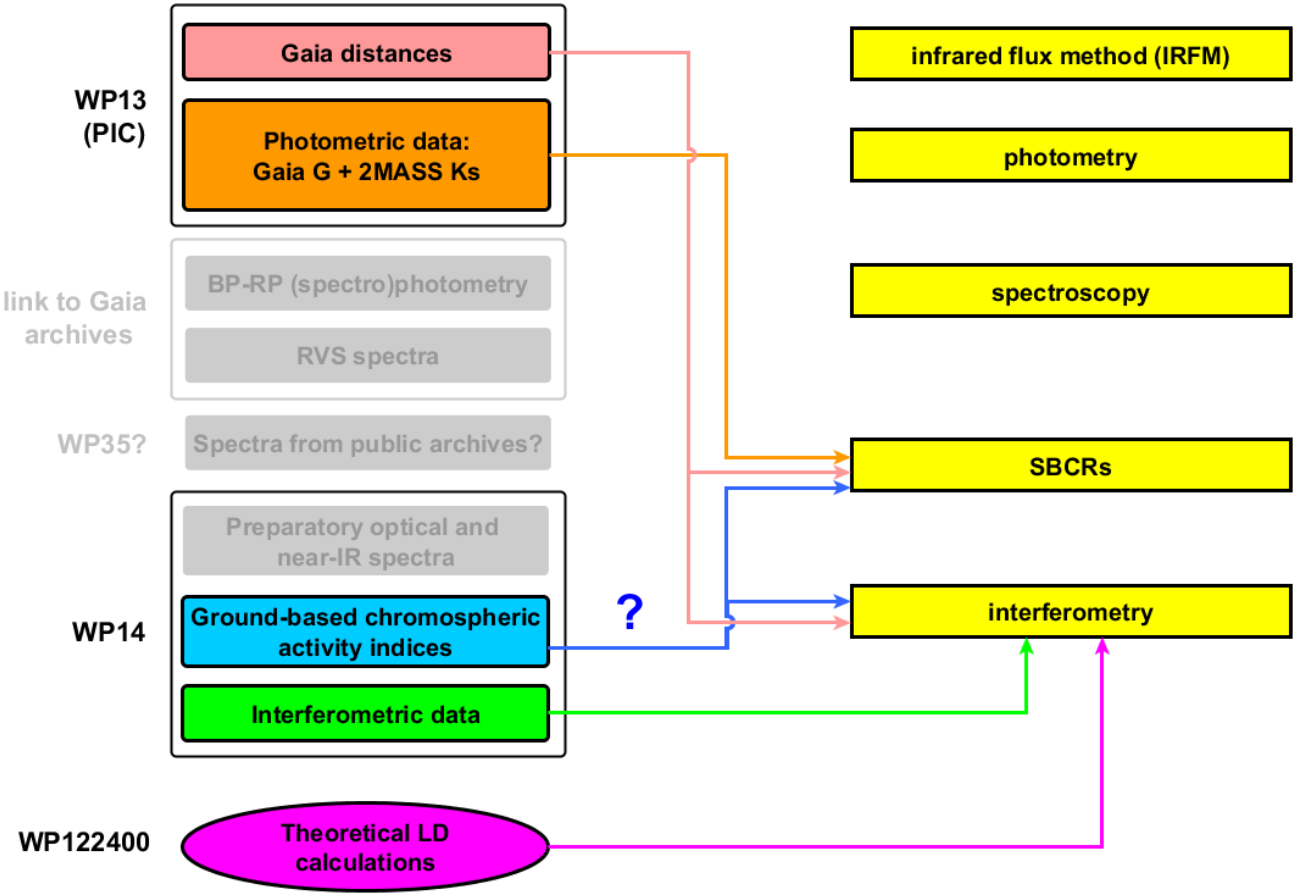
Synergy ISSP-PLATO in practice

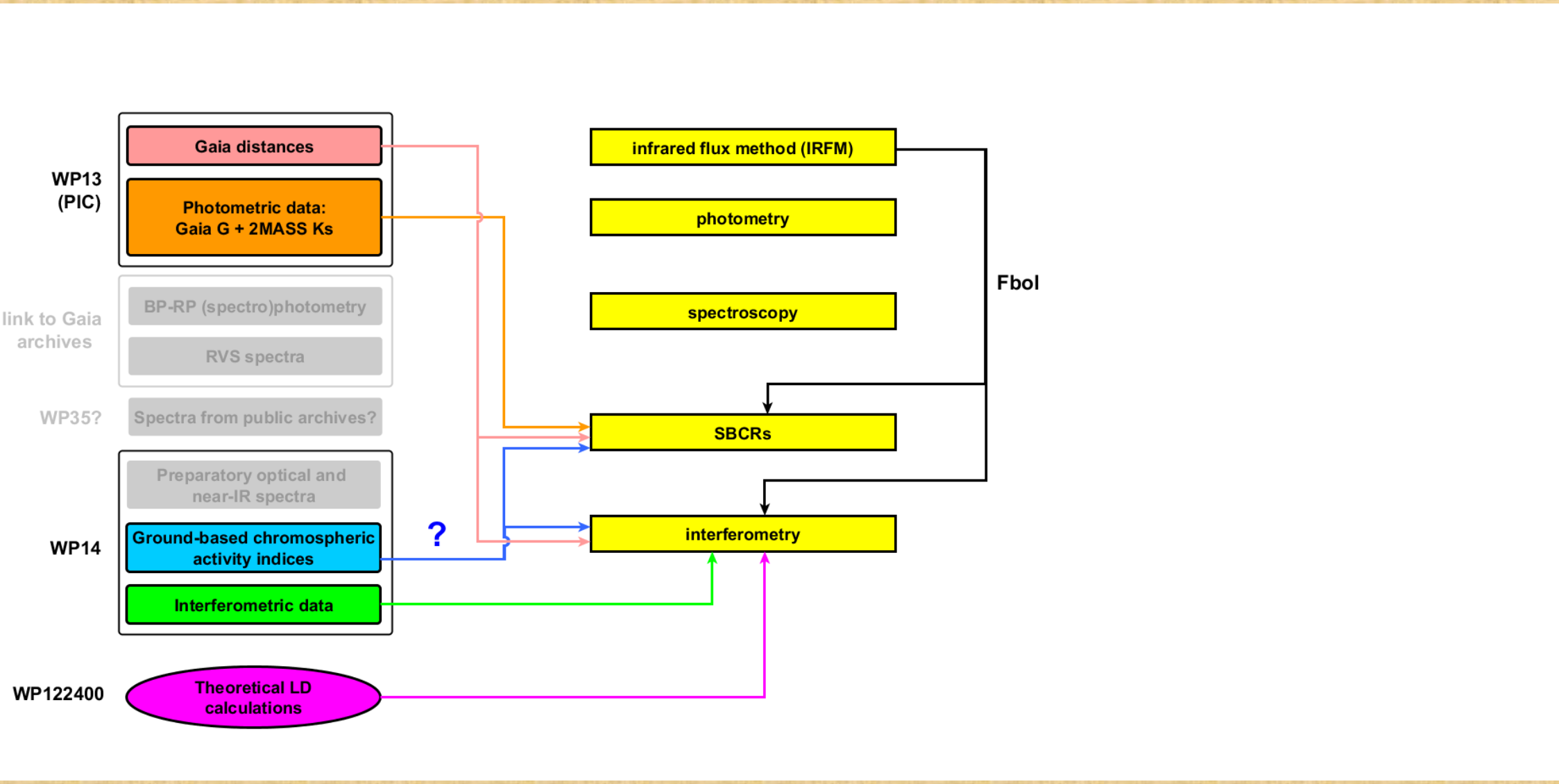
WP14 (aka GOP) « Ground-based Observing Program »

WP145300 « Interferometry» Lead: Denis Mourard	**Task** Organise preparatory/follow-up interferometric observations + interface with pipeline development

WP122 « Non-seismic parameters and model atmospheres »

WG3 in WP122300 « Interferometry» Lead: Denis Mourard	**Task** Develop pipeline for treatment of interferometric data
WG4 in WP122300 « SBCRs» Lead: Nicolas Nardetto	**Task** Develop pipeline for SBCRs


WP13
(PIC)
Gaia distances
Photometric data:
Gaia G + 2MASS Ks
link to Gaia
archives
BP-RP (spectro)photometry
RVS spectra
WP35?
Spectra from public archives?
WP14
Preparatory optical and
near-IR spectra
Ground-based chromospheric
activity indices
Interferometric data
?
WP122400
Theoretical LD
calculations
infrared flux method (IRFM)
photometry
spectroscopy
SBCRs
interferometry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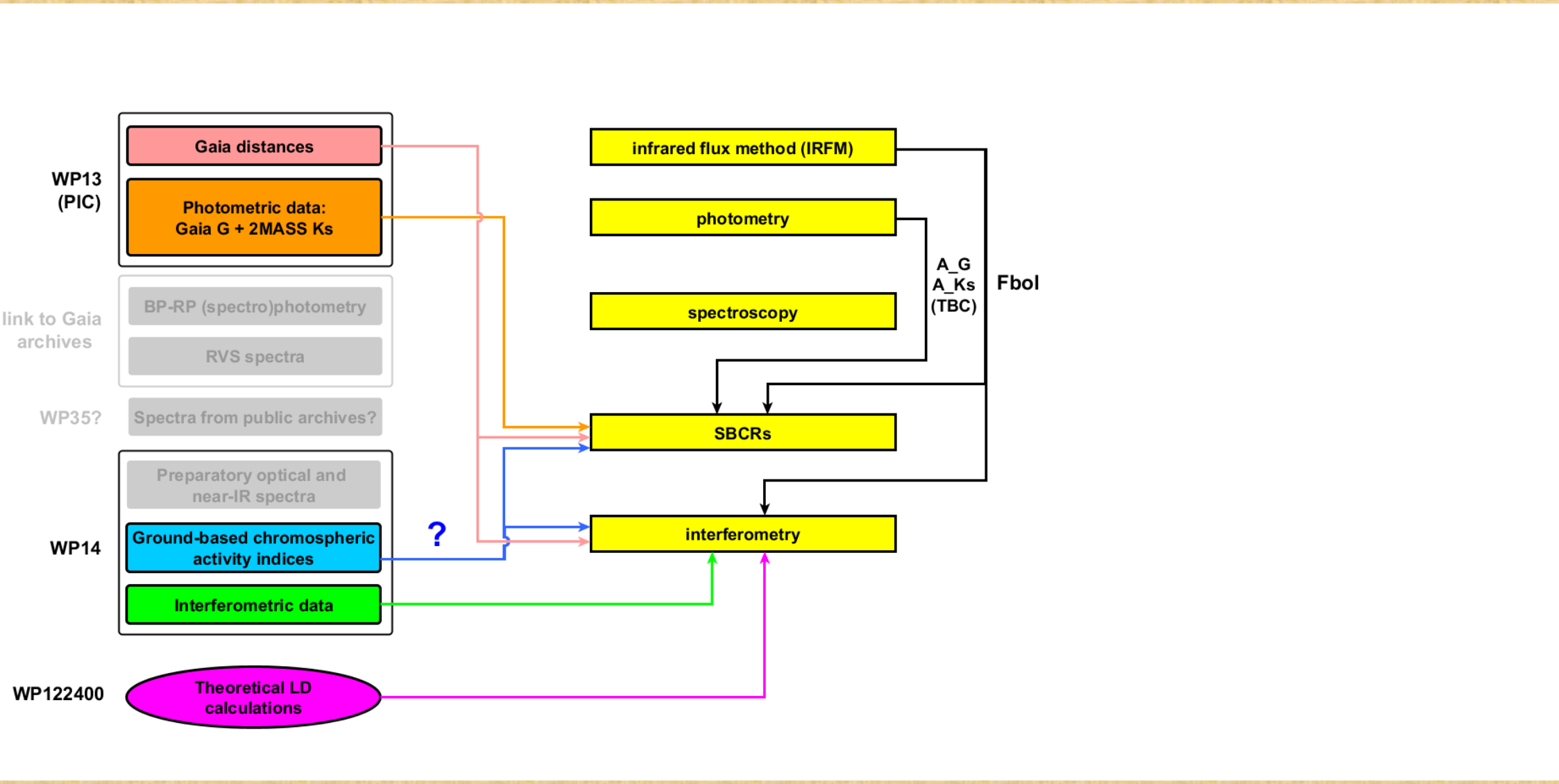
Fbol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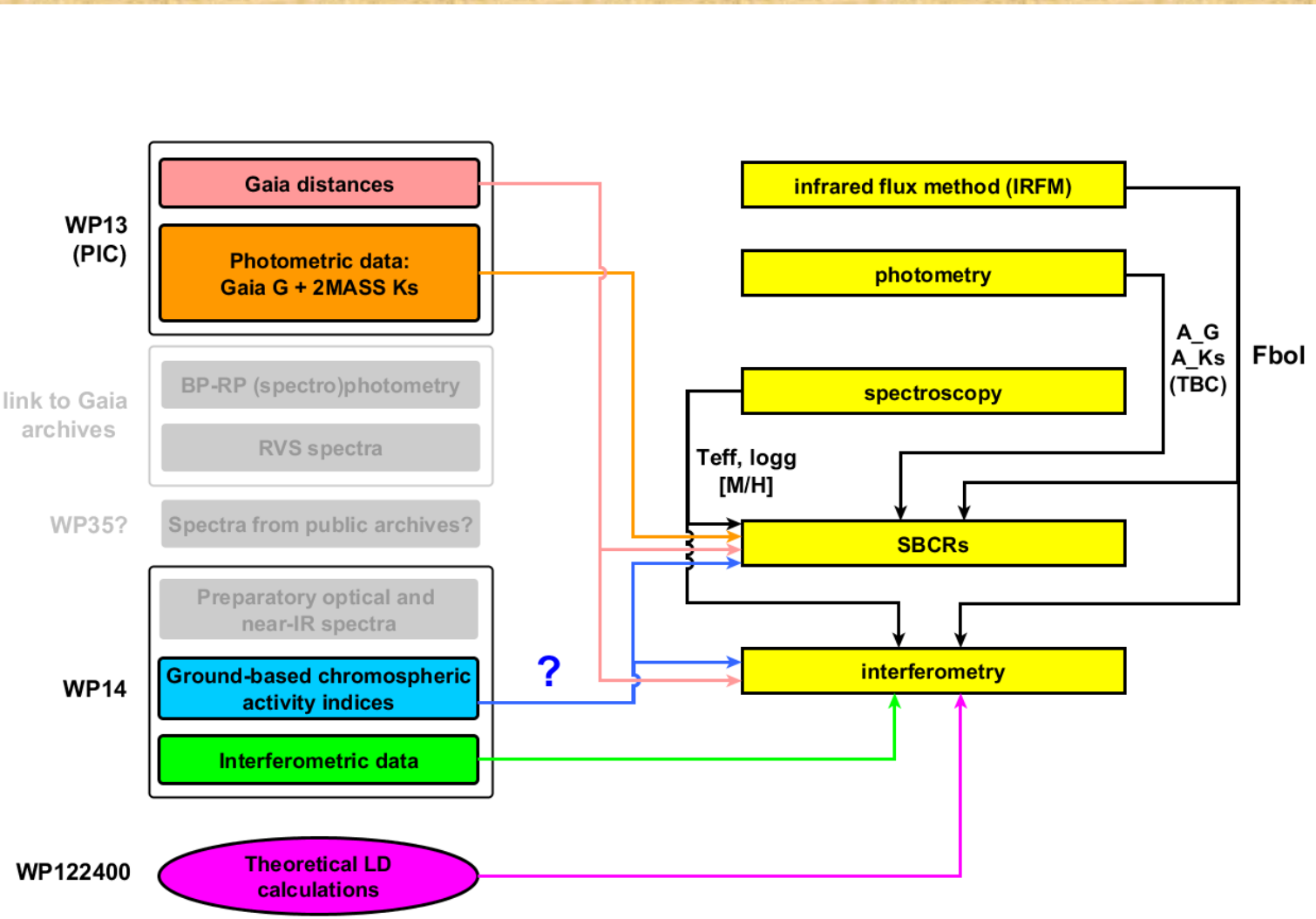
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Teff, logg
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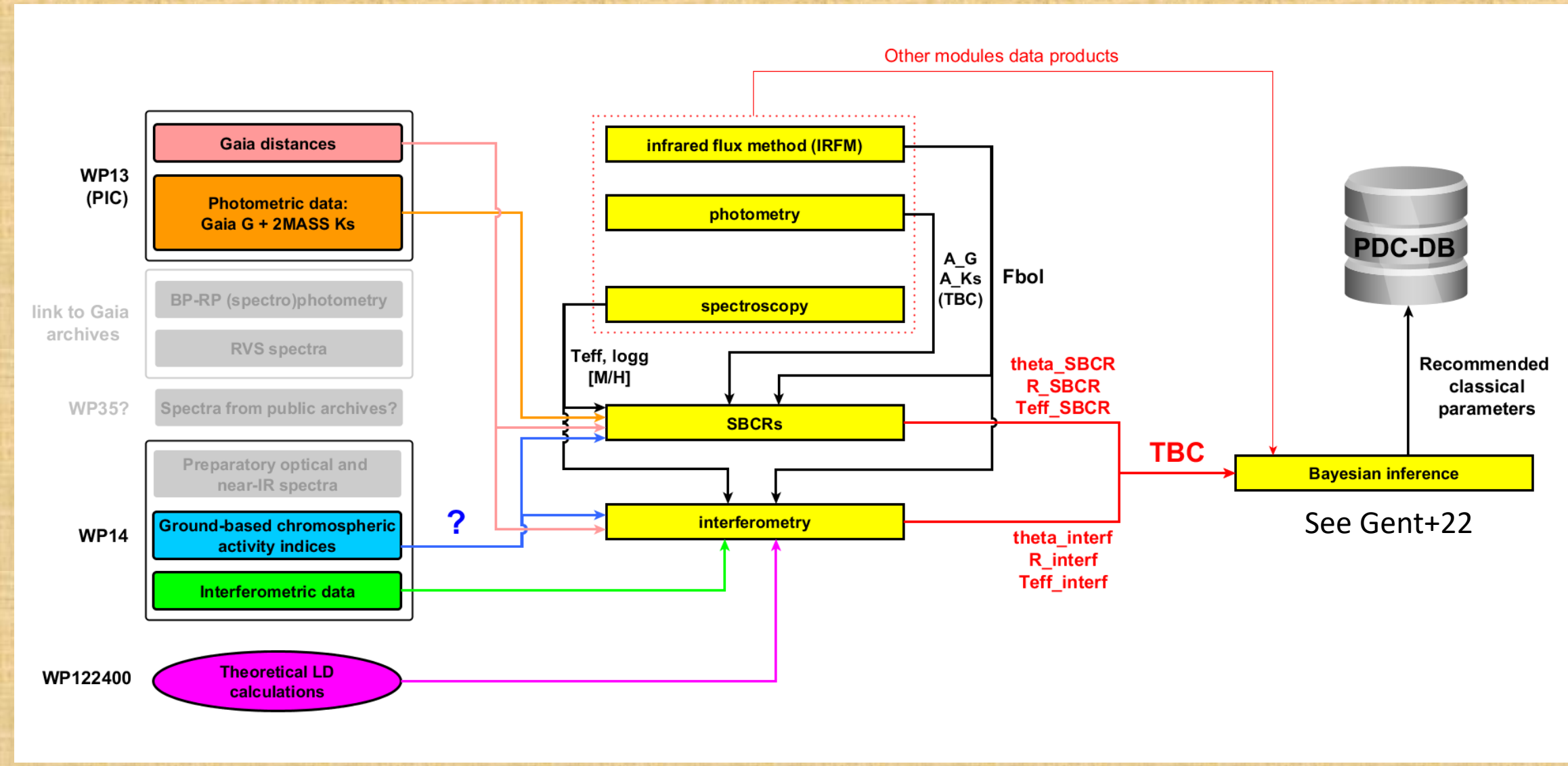
Other modules data products
WP13 (PIC)
Gaia distances
Photometric data: Gaia G + 2MASS Ks
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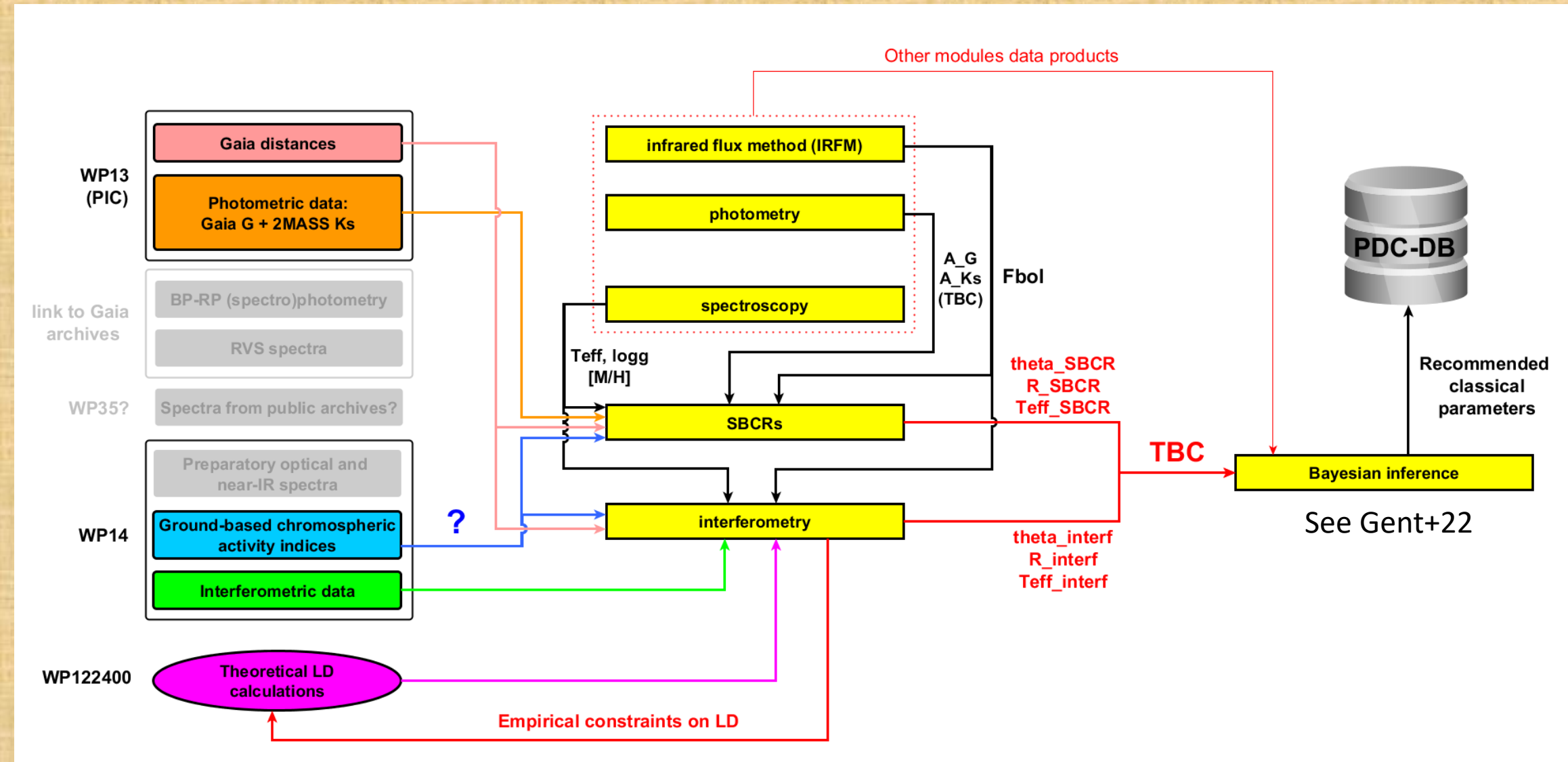
SBCRs
interferometry
theta_SBCR
R_SBCR
Teff_SBCR
theta_interf
R_interf
Teff_interf
TBC
Bayesian inference
PDC-DB
Recommended classical parameters
See Gent+22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TBC
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Recommended classical parameters
See Gent+22
Empirical constraints on LD

Before launch (< Q4 2026)

- Implementation and validation of interferometric and SBCR pipeline modules into PLATO pipeline (MSteSci1 aka BO-SAPP)
- Consolidation of interface with other pipeline units: photometry, spectroscopy, …
- Consolidation of interface between CHARA-SPICA and WP145300 dealing with gathering of interferometric observations for stars in PLATO Input Catalogue (PIC)
- Application of SBCRs to evolving versions of PIC
- Processing of CHARA-SPICA data for PIC targets
- Empirical constraints on LD (e.g. Kervella+17) to inform modellers

After launch (> Q4 2026)

- Interferometric follow-up of POIs
- Application of improved SBCRs, if any

Strong synergy and expertise/(wo)manpower already shared!