Synthesis of WG2

‘Non-seismic diagnostics and model atmospheres’

Question: what accuracy in [Fe/H] and chemical abundances is required?

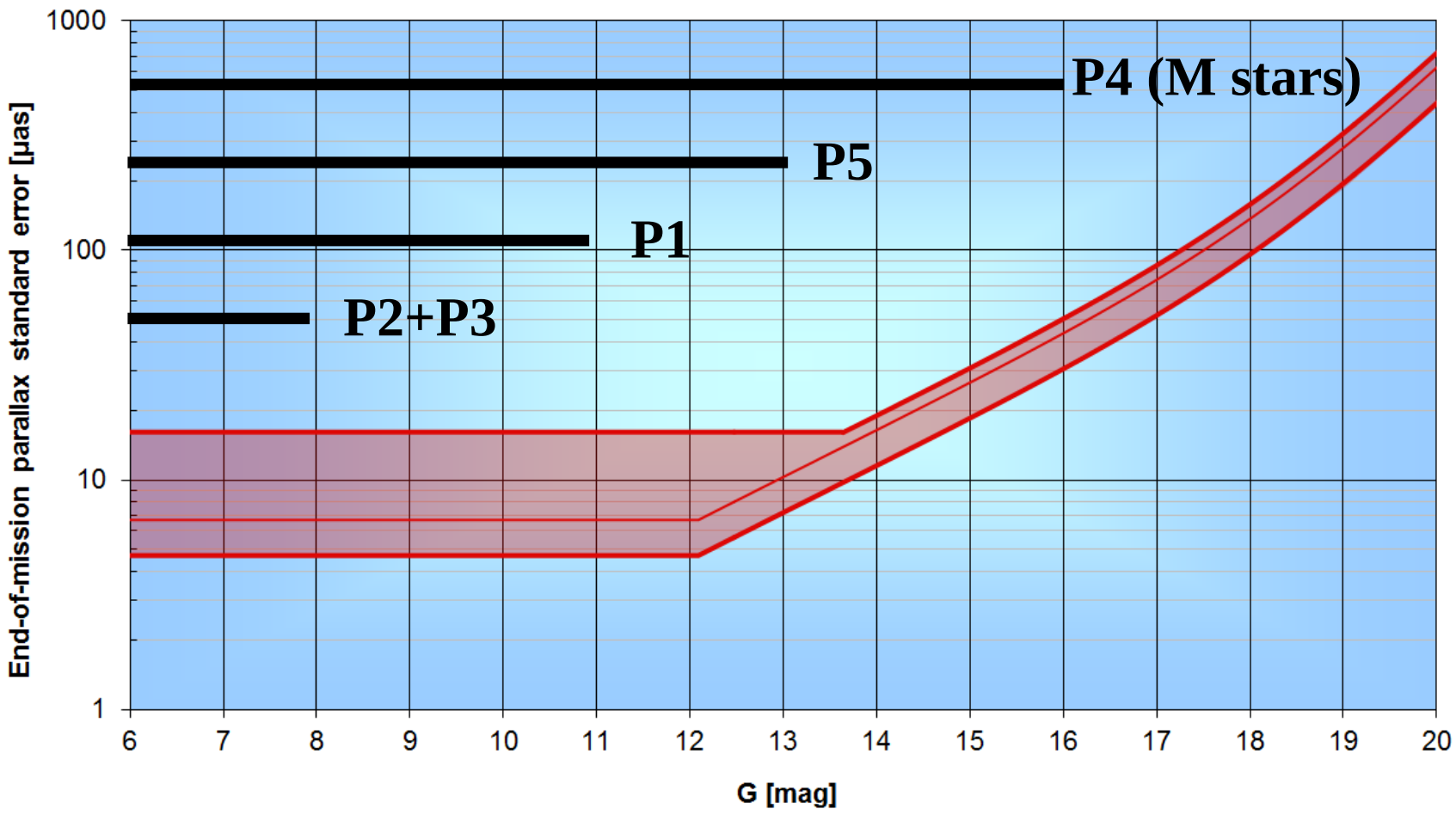
Outputs

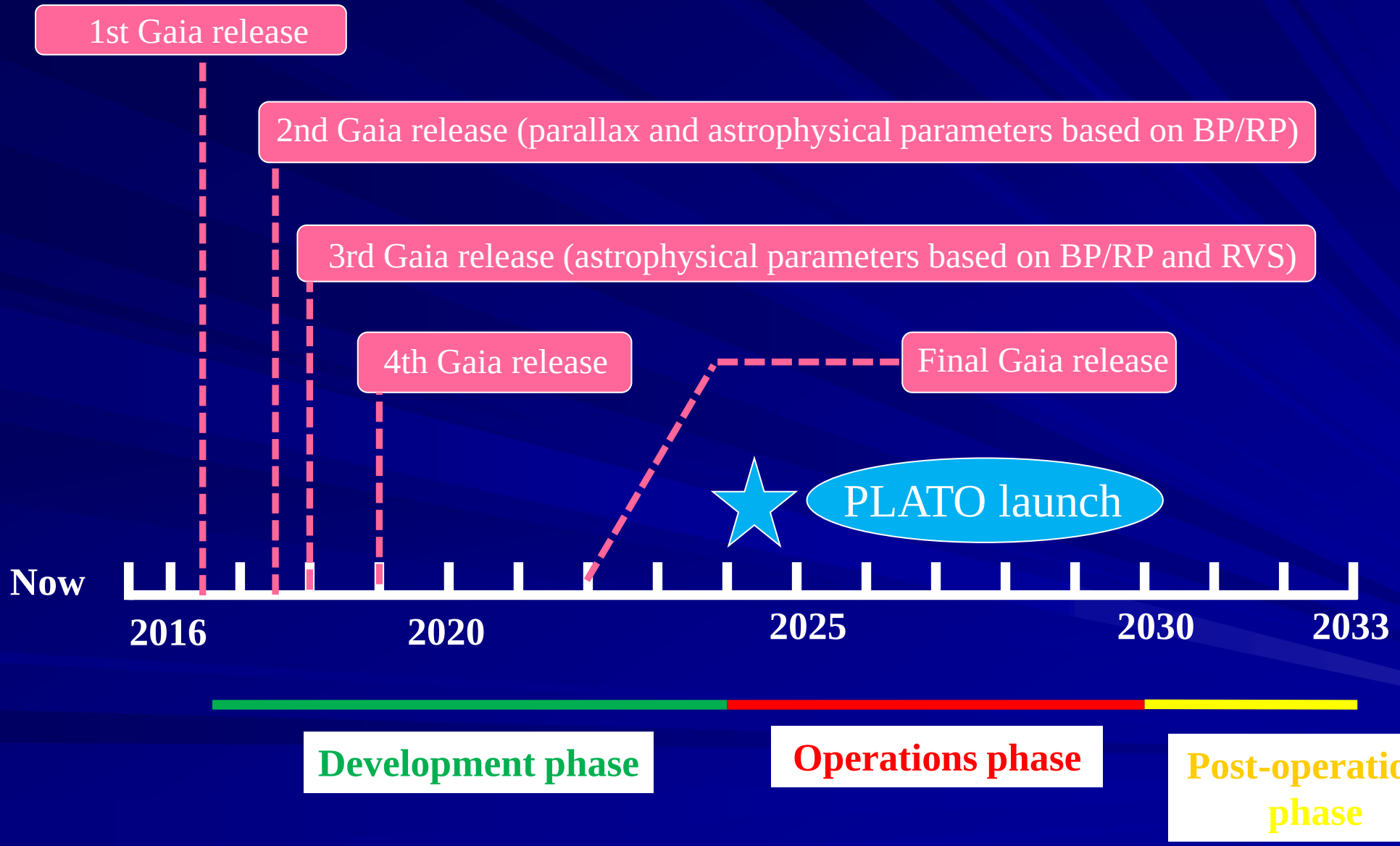
Stellar radii to ~2% for stars in P1-P3 sample
Teff to ~1%
[Fe/H] and [X/Fe] to 0.1 dex at the very least
Grid of model atmospheres
Grid of limb- and gravity-darkening coefficients

Question: what should be the parameter space covered by the grid of atmosphere models?
How dense should be the grid?

Will we have good parallaxes for all stars in P1-P3 sample by PLATO launch?

Astrometry from Gaia




1st Gaia release
2nd Gaia release (parallax and astrophysical parameters based on BP/RP)
3rd Gaia release (astrophysical parameters based on BP/RP and RVS)
4th Gaia release
Final Gaia release
PLATO launch
Now
2016
2020
2025
2030
2033
Development phase
Operations phase
Post-operations phase

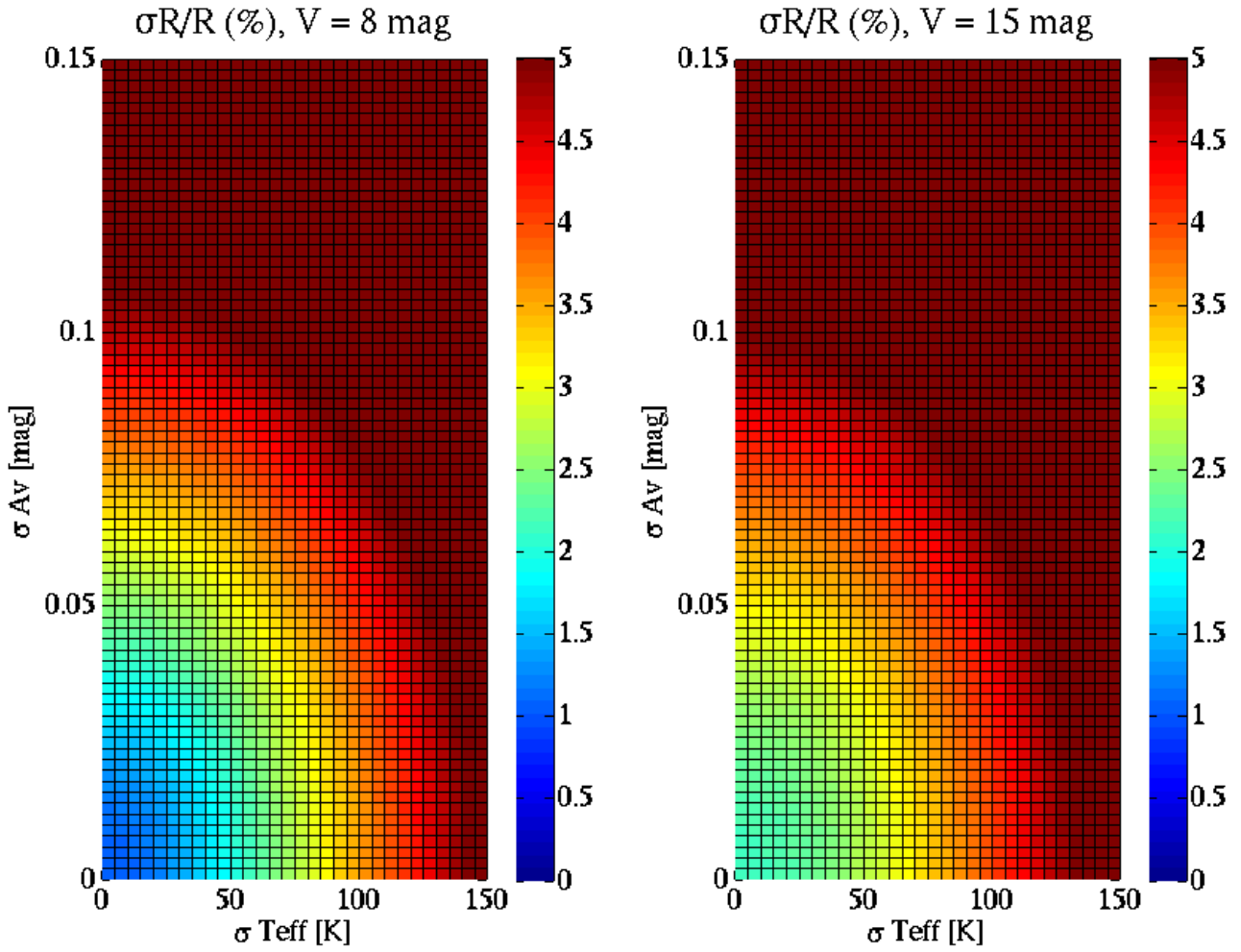
Can Gaia provide an accuracy of 2% in stellar (i.e., planetary) radii?

If we have a good handle on T_{eff} and reddening

$$M_V = V + 5 + 5\log\pi - A_V$$

$$\log(L/L_\odot) = (M_{\mathrm{bol},\odot} - M_V - BC)/2.5$$

$$R = (L/4\,\pi\,\sigma\,T_{\mathrm{eff}}^4)^{1/2}$$



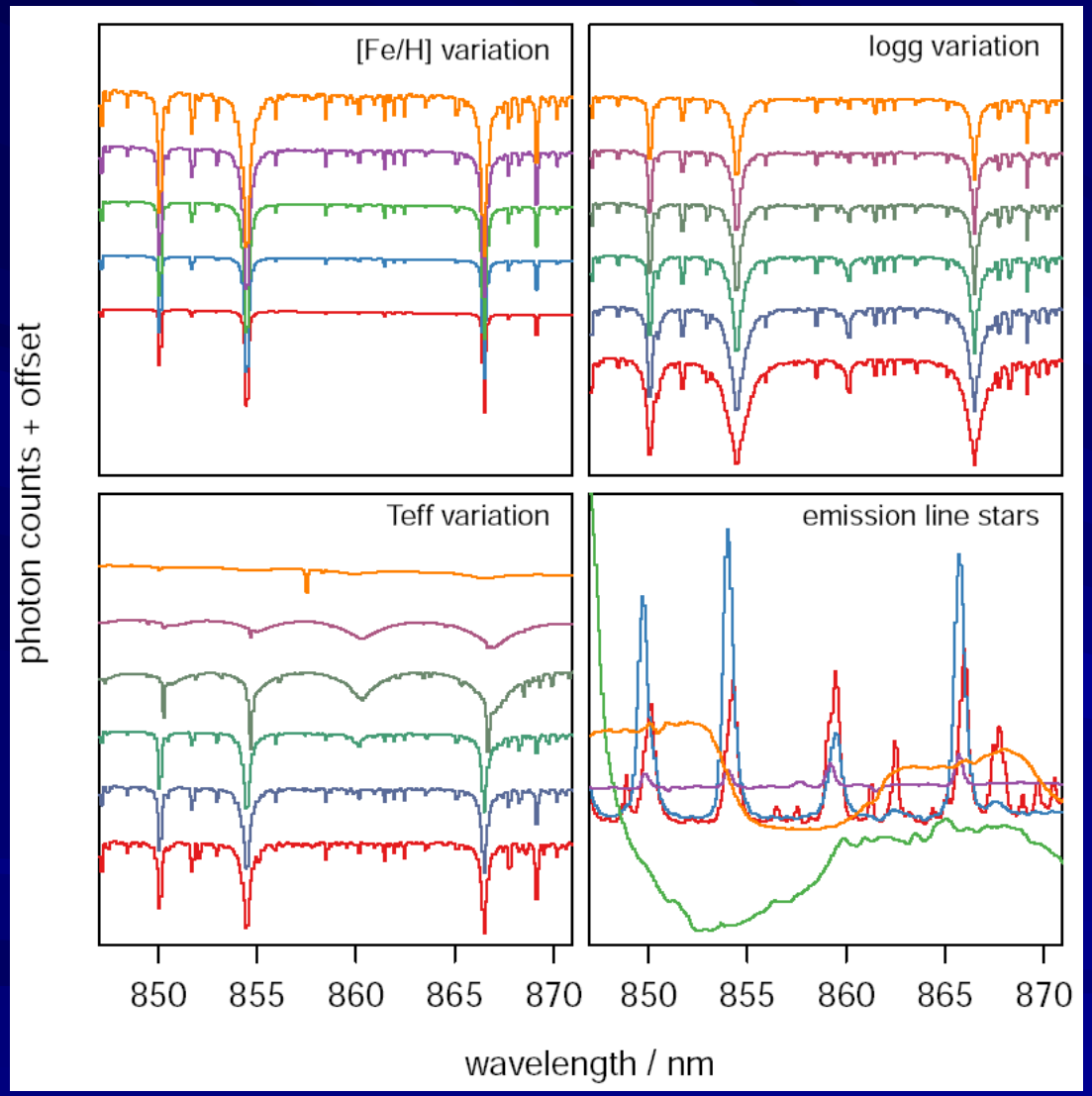
σBC = 0.02 mag assumed

σ_π = 15 and 24 μas assumed for V = 8 and 15 mag, respectively

Will Gaia provide these quantities with a sufficient accuracy?

Teff	
Reddening	
Chemical abundances	

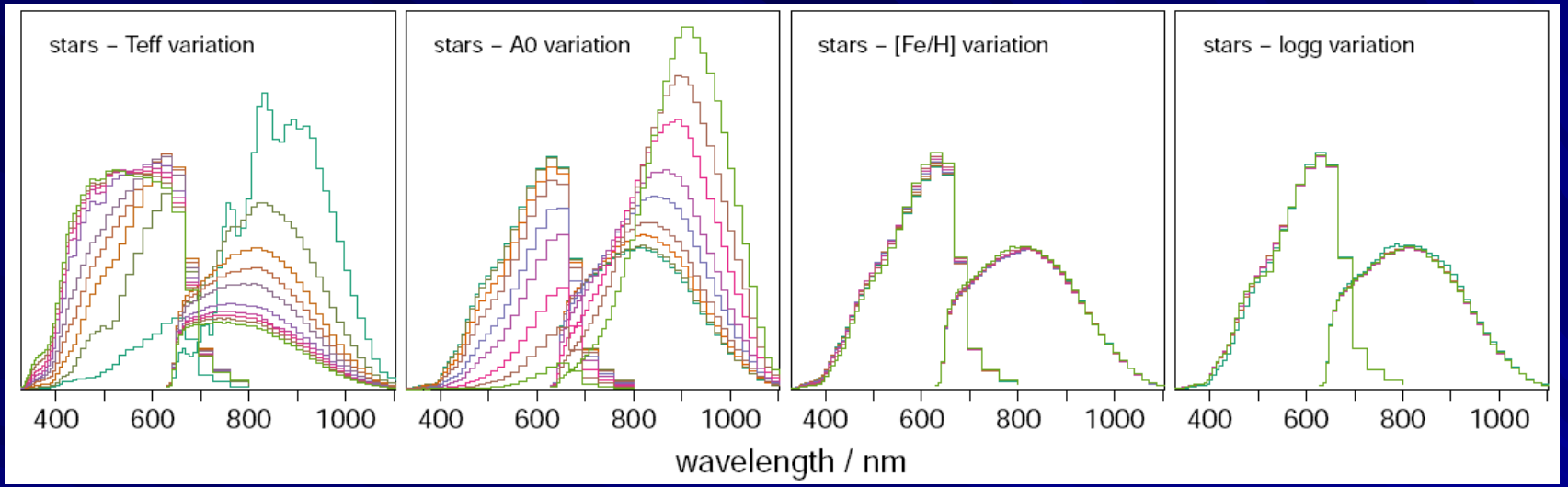
GSP-Spec performance (internal rms errors)



	G_{RVS} mag	T_{eff} K	log g dex	[M/H] dex
Thin disk dwarfs	10	60	0.08	0.09
	13	70	0.12	0.09
	15	270	0.39	0.30
Thick disk dwarfs	10	70	0.11	0.09
	13	110	0.17	0.12
	15	350	0.43	0.29
Halo giants	10	70	0.17	0.15
	13	90	0.28	0.17
	15	340	0.86	0.38

Bailer-Jones et al. (2013)

GSP-Phot performance (internal rms errors)



	G mag	$T_{\rm eff}$ K	A_0 mag	$\log g$ dex	[Fe/H] dex
A stars	9	340	0.08	0.43	0.86
	15	260	0.06	0.38	0.93
	19	400	0.15	0.51	0.74
F stars	9	150	0.06	0.36	0.36
	15	170	0.07	0.38	0.33
	19	630	0.35	0.37	0.60
G stars	9	140	0.07	0.31	0.14
	15	140	0.07	0.22	0.16
	19	450	0.33	0.45	0.65
K stars	9	100	0.09	0.26	0.19
	15	90	0.08	0.26	0.21
	19	230	0.23	0.36	0.48
M stars	9	60	0.13	0.15	0.21
	15	70	0.14	0.29	0.25
	19	90	0.13	0.17	0.29

Bailer-Jones et al. (2013)

Can photometry (IRFM) provide Teff with a sufficient accuracy?

Very sensitive to reddening which will be fairly poorly constrained for most stars in P1 with *V*~10-11 mag

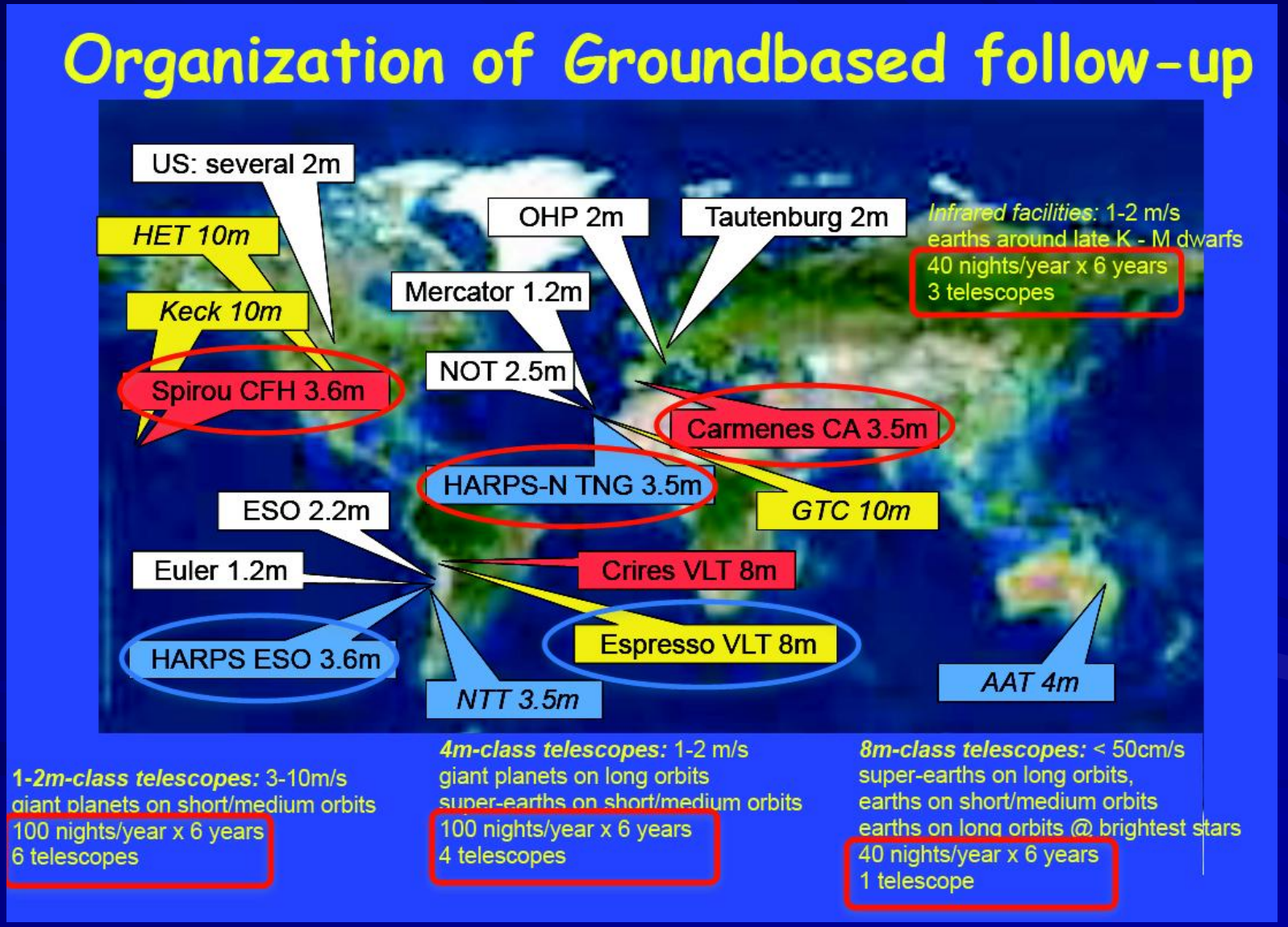
Can high-resolution spectroscopy provide these quantities with a sufficient accuracy?

Teff 

Reddening 

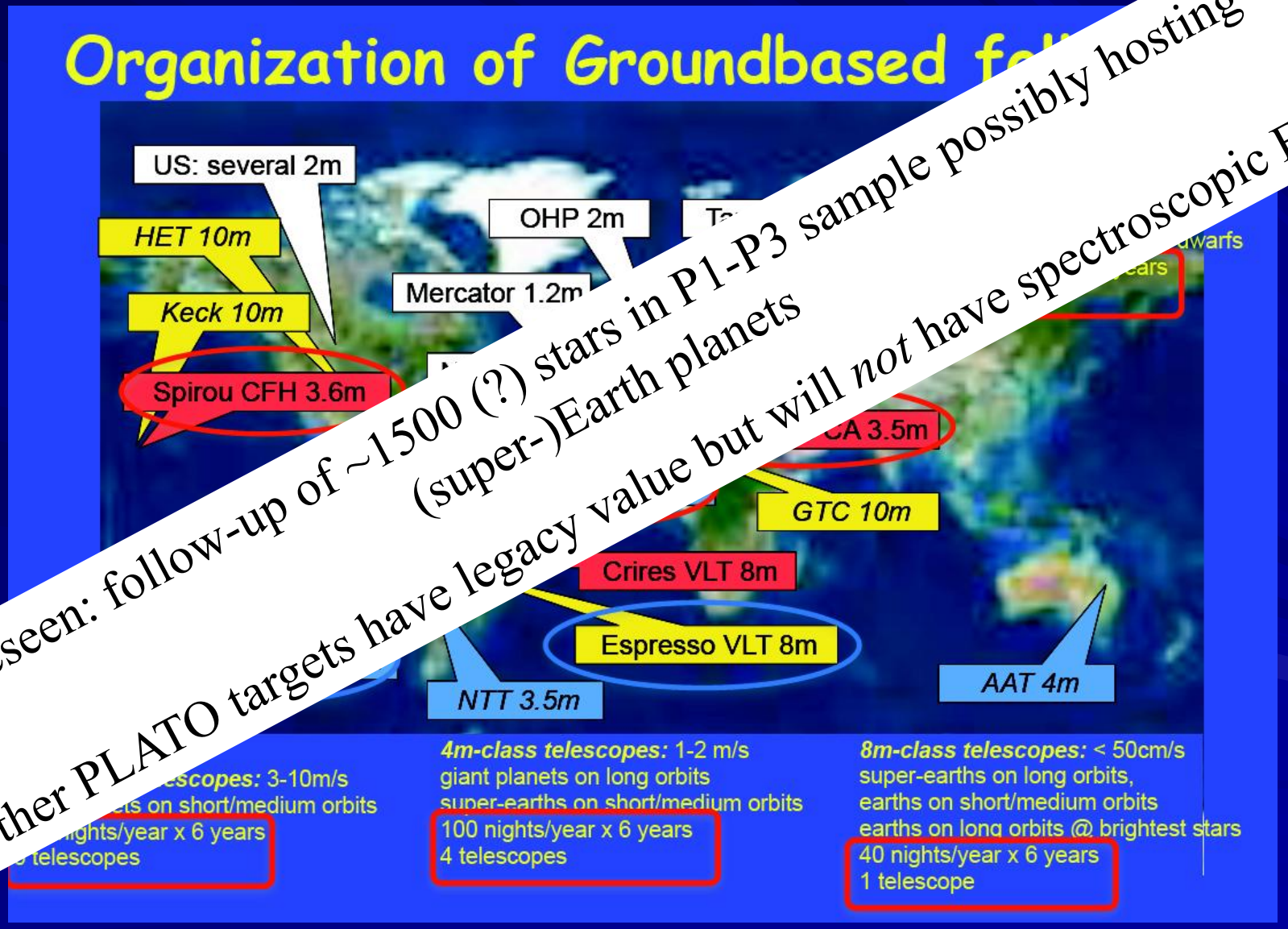
Chemical abundances 

High-resolution spectra from follow-up



Courtesy S. Udry

High-resolution spectra from follow-up



Foreseen: follow-up of ~1500 (?) stars in P1-P3 sample possibly hosting (super-)Earth planets

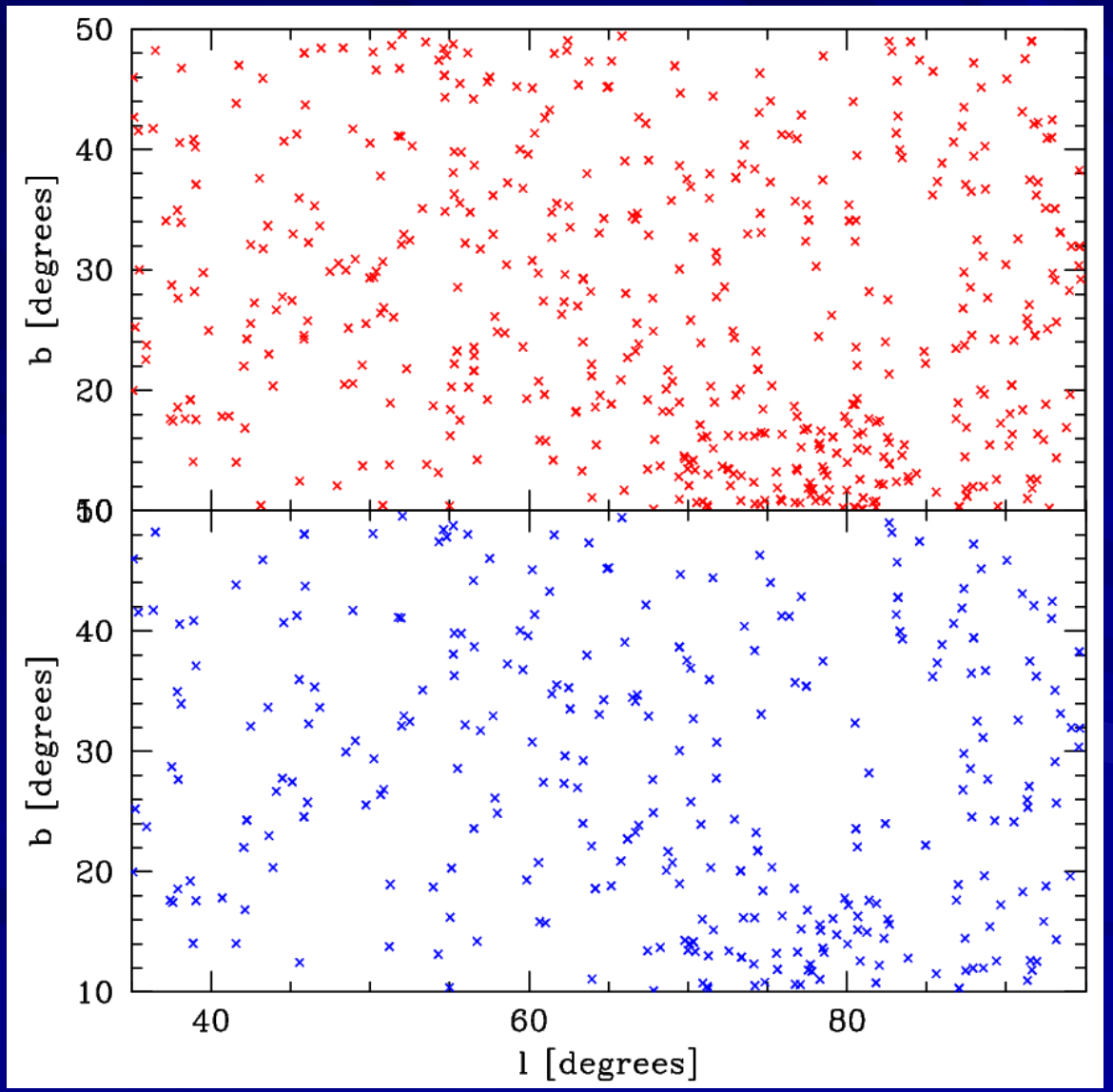
Other PLATO targets have legacy value but will *not* have spectroscopic FU

Courtesy S. Udry

High-resolution spectra from archives

All stars

Stars with V > 8



Stars in SOPHIE archives for one of the long-pointing PLATO fields

Spectroscopic data from large-scale spectroscopic surveys

Name	R	Number of stars	Magnitude range	Facility	Status
RAVE	7 500	$\sim 5\times10^5$	$V < 12$	AAO	Completed
SDSS-SEGUE	2 000	$\times10^5$	$g < 19$	APO	Completed
Gaia/RVS	11 500	$\times10^7$	$V < 14$	Gaia	Ongoing
LAMOST	1 800	$\times10^6$	$V < 19$	Xinglong station	Ongoing
GALAH	28 000	$\sim10^6$	$12 < V < 14$	AAO	Ongoing
Gaia-ESO	20 000	$\sim10^5$	$V < 19$	ESO	Ongoing
WEAVE	20 000	$\times10^5$	$V < 18$	ING	Starting $\sim$2017
4MOST	20 000	$\sim1.5\times10^6$	$V < 15$	ESO	Starting $\sim$2020

Medium-resolution surveys

Conclusion

High- or medium-resolution spectroscopy is probably the most promising way to estimate Teff (and reddening?) and the only one for the chemical abundances

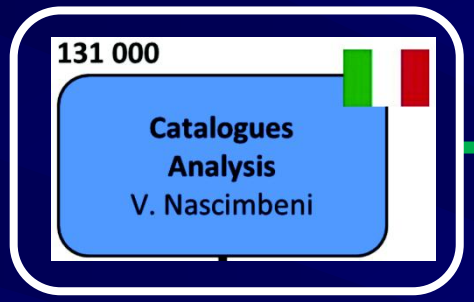
Accuracy of ~50 K in Teff and ~0.05 dex in [Fe/H] already achievable for solar analogues through differential analyses with respect to the Sun

Problem:

Only a small fraction of stars in P1 will have data from archives and FU + inhomogeneous data

Possible solution:

Preparatory observations (through WP131330) and/or agreement with ongoing or future large-scale spectroscopic surveys (e.g., 4MOST)

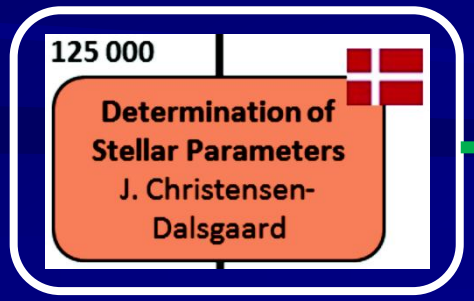


WP131100: Gaia parallaxes
WP131200-131300: Archive data (spectroscopic, photometric, …)
WP131330: Preparatory observations?

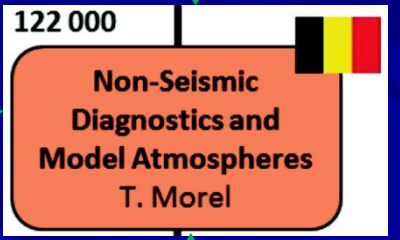
WP131100-131200-131300: First guess of parameters from Gaia and existing catalogues

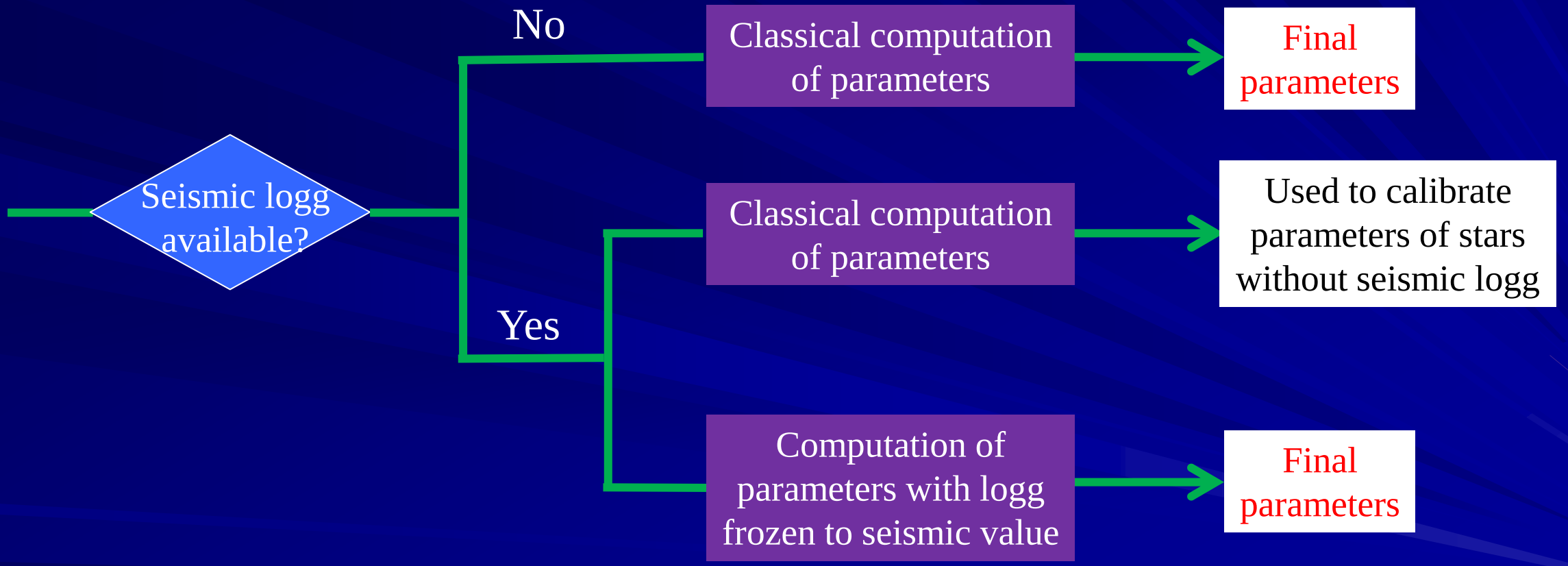
WP146000: Follow-up data (starting from operations phase)

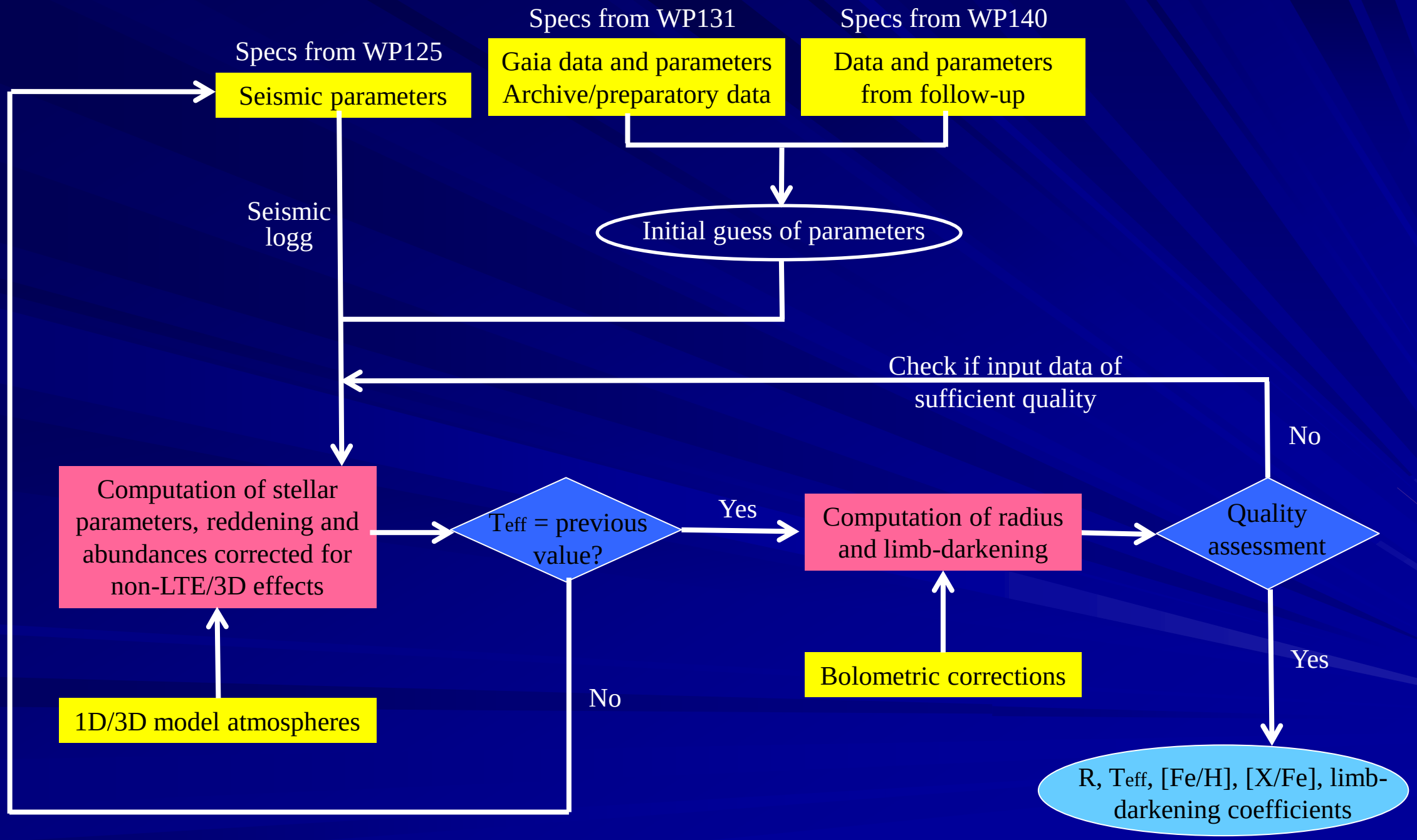
WP146000: Rough parameters (starting from operations phase)



WP125000: Seismic gravities (starting from operations phase)




Seismic logg available?
No
Yes
Classical computation of parameters
Final parameters
Classical computation of parameters
Used to calibrate parameters of stars without seismic logg
Computation of parameters with logg frozen to seismic value
Final parameters


Specs from WP125
Seismic parameters
Specs from WP131
Gaia data and parameters
Archive/preparatory data
Specs from WP140
Data and parameters
from follow-up
Seismic
logg
Initial guess of parameters
Check if input data of
sufficient quality
No
Computation of stellar
parameters, reddening and
abundances corrected for
non-LTE/3D effects
Teff = previous
value?
Yes
Computation of radius
and limb-darkening
Quality
assessment
Yes
No
Bolometric corrections
1D/3D model atmospheres
R, Teff, [Fe/H], [X/Fe], limb-
darkening coefficients

Benchmarks stars

We came to the conclusion that benchmark stars are essential for:
Testing the reliability of the model atmospheres
Assessing the accuracy of the parameters

Proposal to create a dedicated subWP within WP122000
Led by Ulrike Heiter (?)
People from the interferometric community more than welcome

Work to be done in the next few weeks/months

Definition of a set of benchmark stars

Example:
β Hydri (G0 IV)
Teff=5872±44 K
logg=3.98±0.02 dex
[Fe/H]=-0.04±0.02

Accuracy assessments