PLATO INPUT CATALOG (PIC)

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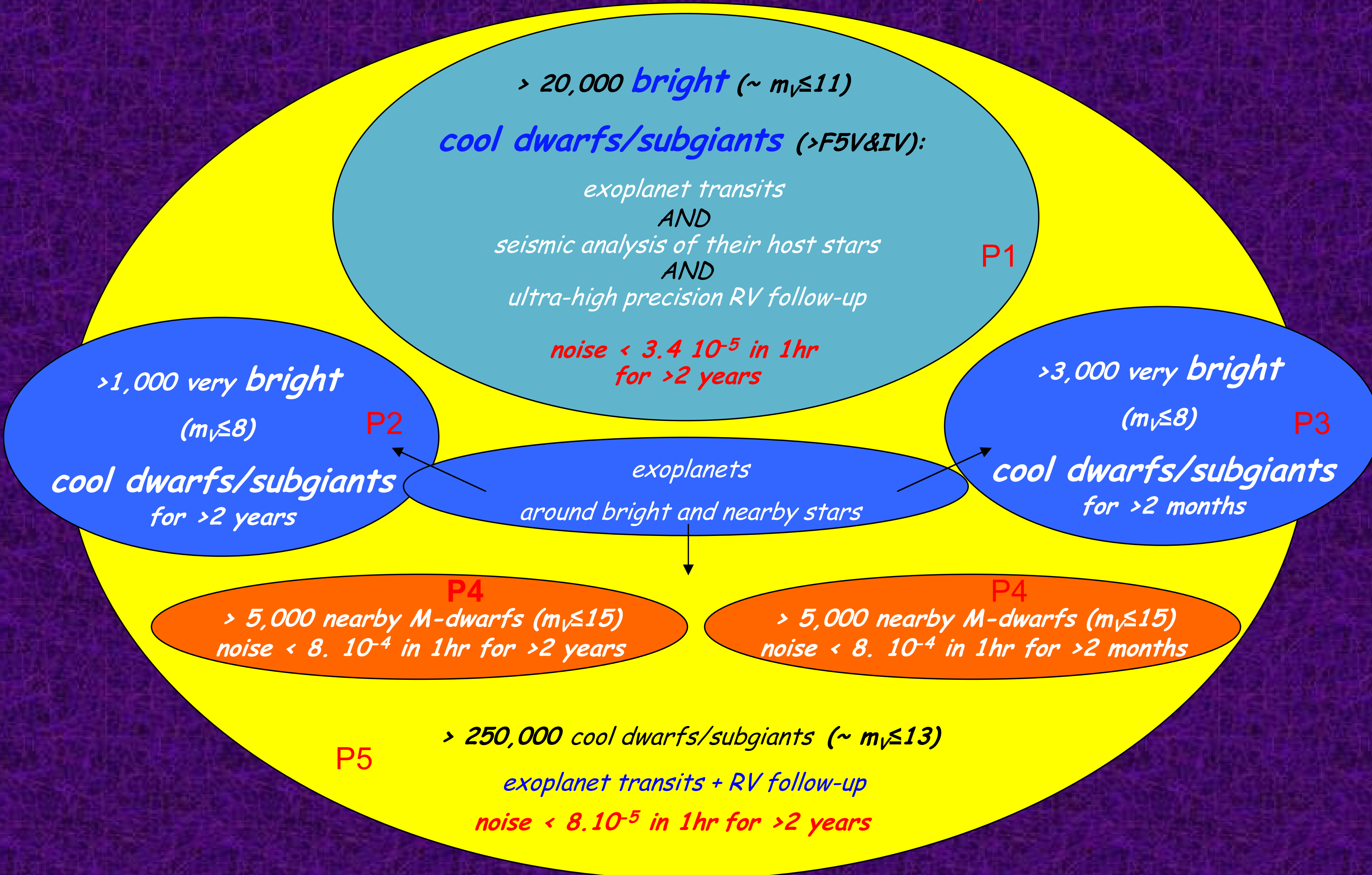
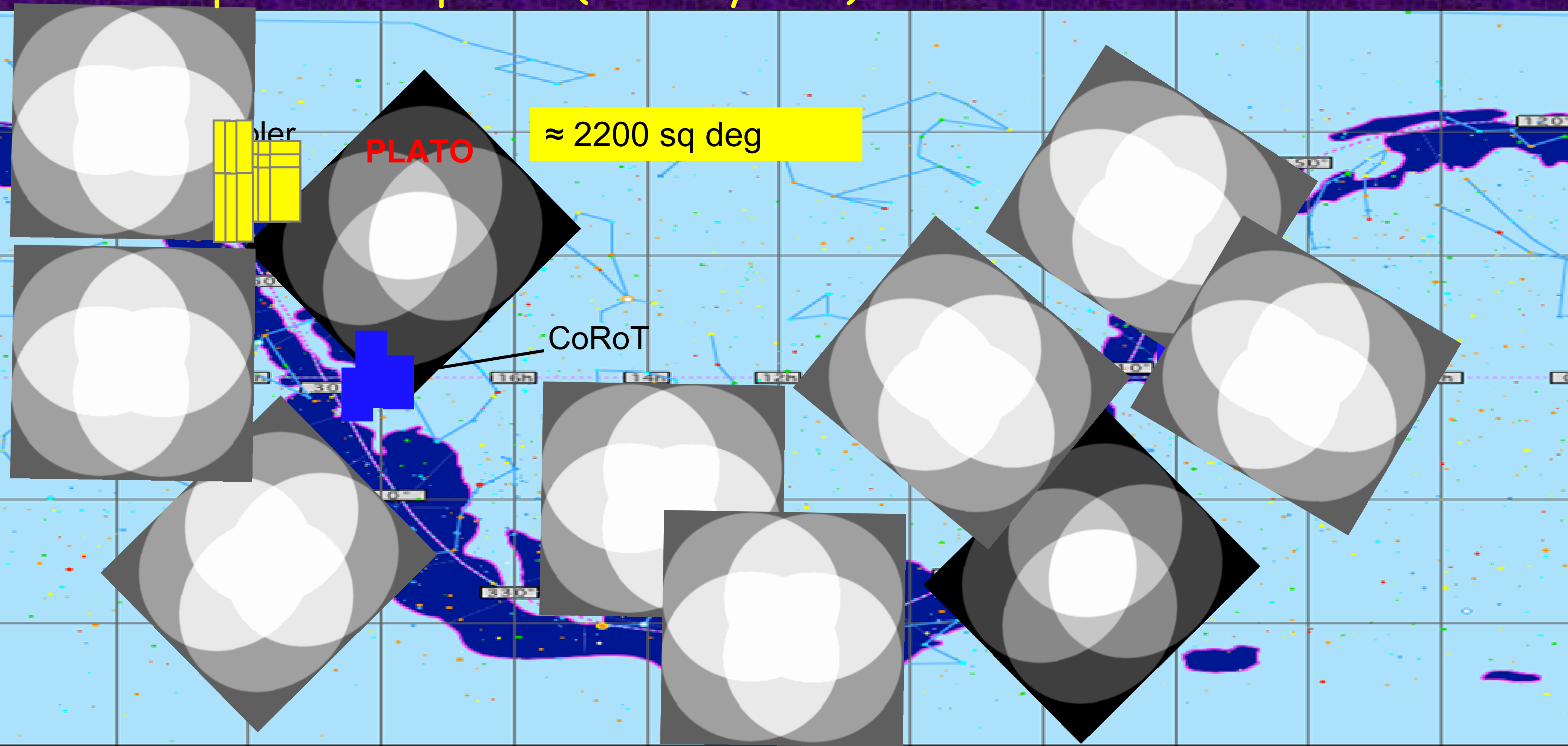
PLATO target samples



Sky coverage

Observation strategy:

1. two long pointings : 3 years or 2 years
2. « step&stare » phase (1 or 2 years) : *N* fields 2-5 months each



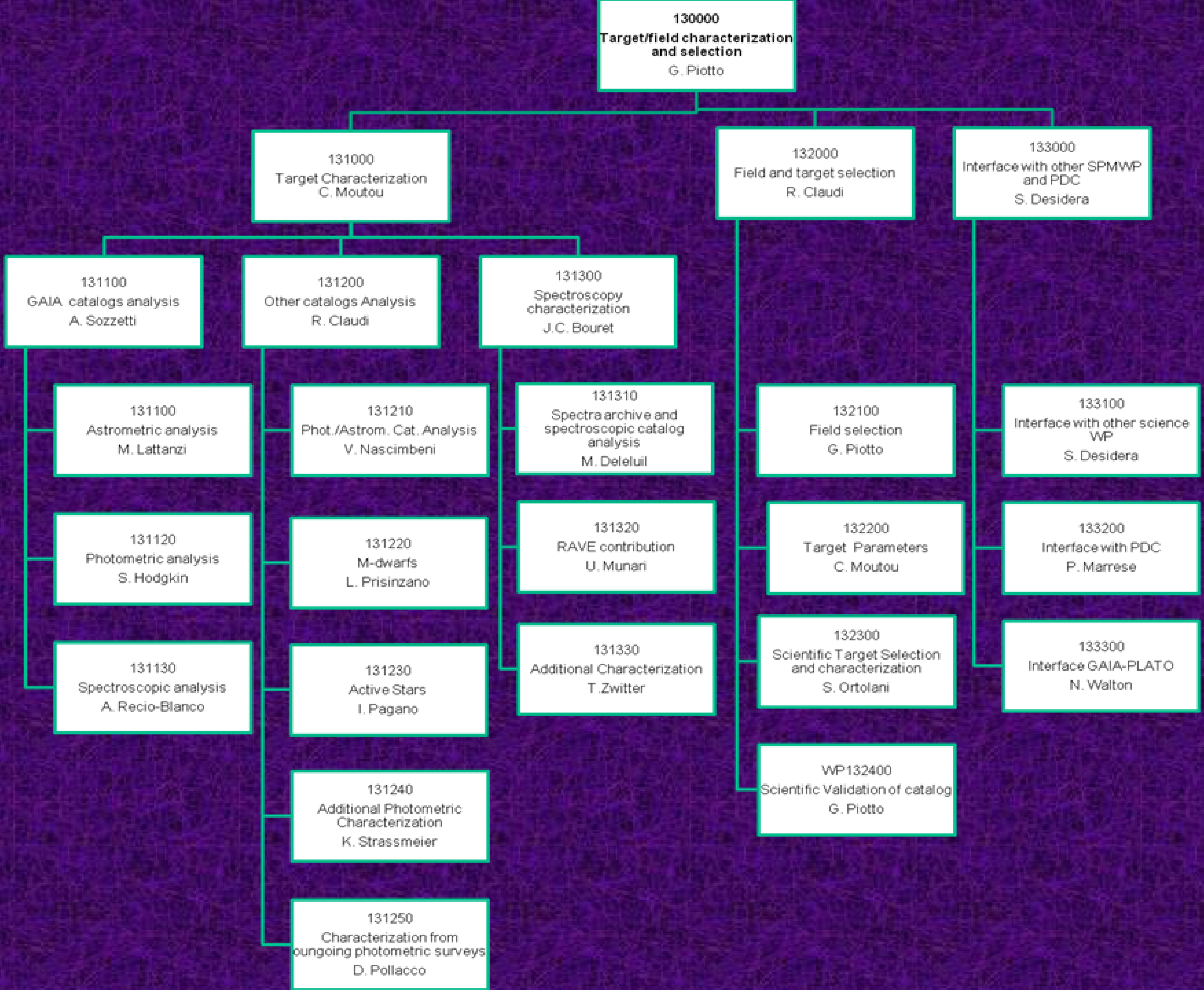
20,000 sqdeg ➔ 50% of the sky !

How shall we select PLATO targets?

1. GAIA, starting with GAIA early release catalog

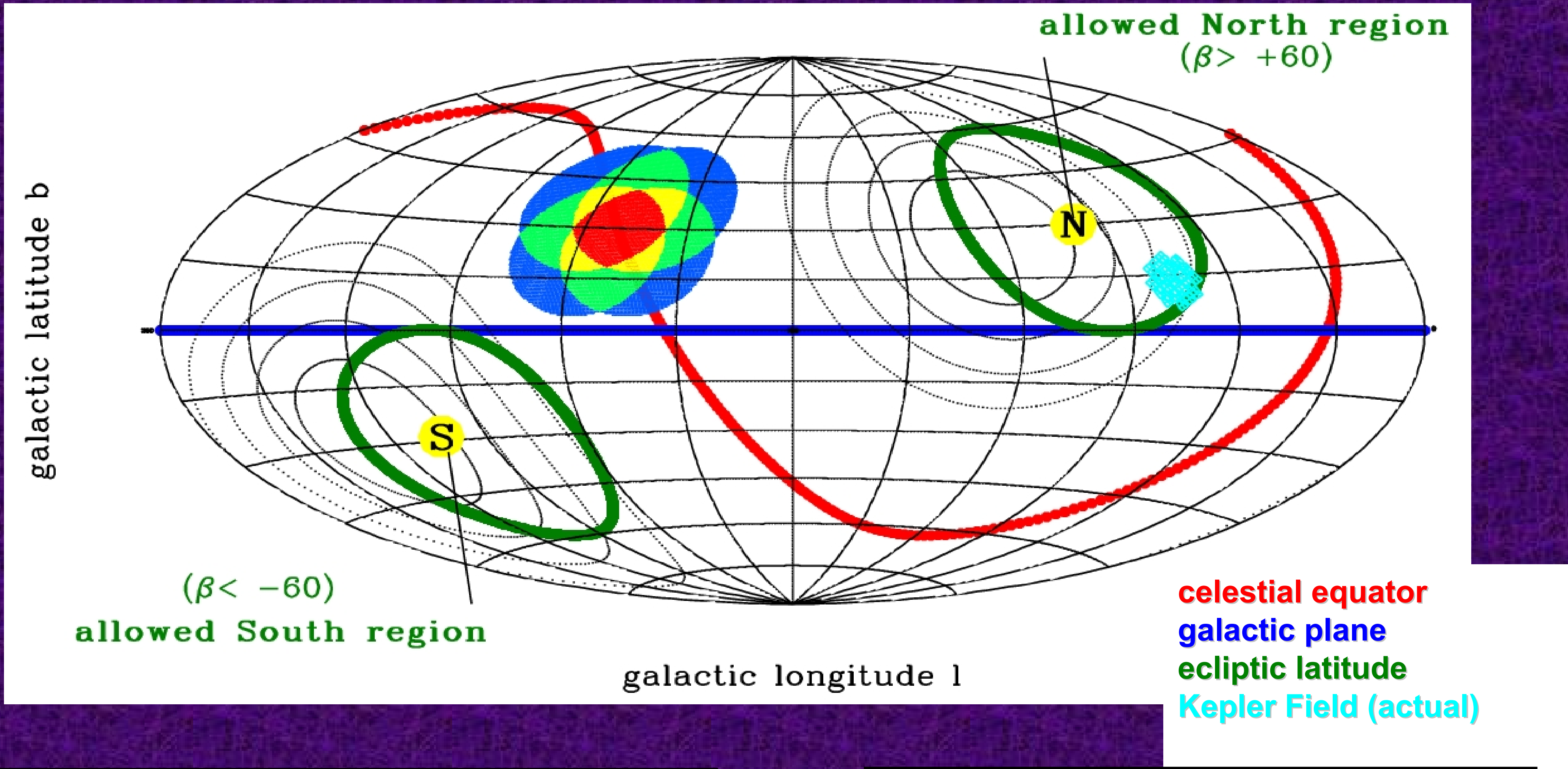
2. Available ground-based and space photometric and astrometric catalogs, for first field selection, to support first long term monitoring field target selection, and....as a backup

Once the targets will be selected, we need, for each target, to include a list of parameters, for the final target selection, and for the target characterization.
The target list and their parameters will constitute the **PLATO Input Catalog (PIC)**



130000
Target/field characterization and selection
G. Piotto
131000
Target Characterization
C. Moutou
132000
Field and target selection
R. Claudi
133000
Interface with other SPMWP and PDC
S. Desidera
131100
GAIA catalogs analysis
A. Sozzetti
131200
Other catalogs Analysis
R. Claudi
131300
Spectroscopy characterization
J.C. Bouret
131100
Astrometric analysis
M. Lattanzi
131120
Photometric analysis
S. Hodgkin
131130
Spectroscopic analysis
A. Recio-Blanco
131210
Phot./Astrom. Cat. Analysis
V. Nascimbeni
131220
M-dwarfs
L. Prisinzano
131230
Active Stars
I. Pagano
131240
Additional Photometric Characterization
K. Strassmeier
131250
Characterization from oungoing photometric surveys
D. Pollacco
131310
Spectra archive and spectroscopic catalog analysis
M. Deleluil
131320
RAVE contribution
U. Munari
131330
Additional Characterization
T.Zwitter
132100
Field selection
G. Piotto
132200
Target Parameters
C. Moutou
132300
Scientific Target Selection and characterization
S. Ortolani
WP132400
Scientific Validation of catalog
G. Piotto
133100
Interface with other science WP
S. Desidera
133200
Interface with PDC
P. Marrese
133300
Interface GAIA-PLATO
N. Walton

Observable regions



The center of the two long-duration (LD) fields must be located within 30 deg from the ecliptic poles (|β|>60). Thus the **allowed regions** are two 2750 deg^2 caps at |δ|>40. Each **Plato FOV** will cover ~2200 deg^2

During the 5-yr mission (LD+S&S phases) almost 5**0%** of the sky will be covered by Plato! We need an unprecedented **all-sky stellar classification (8<*V*<13-13.5)** to select the fields and the targets.

How to tell dwarfs from giants

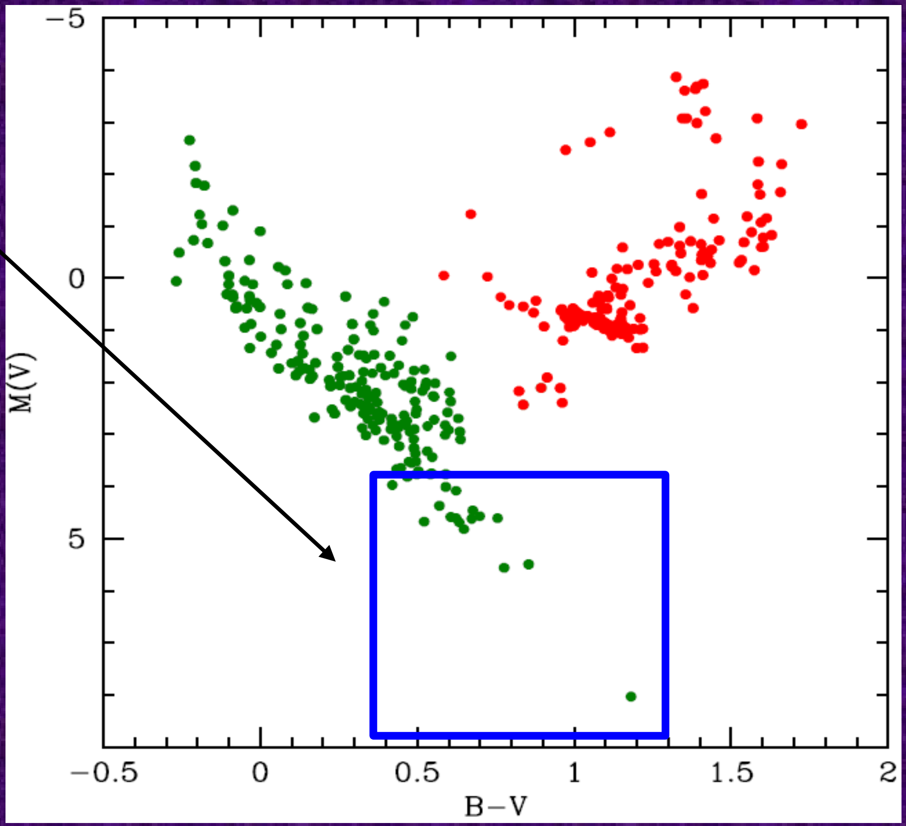
The Plato SciRD states that the targets in the stellar samples P1, P2, P3, P5 must be **late-type (SpT>=F5) dwarfs and subgiants**.

Both observations and simulations show that, in a typical magnitude-limited field close to the galactic plane, **most stars are giants and early-type MS stars**. In principle, the best techniques to identify our targets are:

- spectroscopy
- parallaxes
- narrow- or medium-band photometry (e.g. Kepler Input Catalogue)

These data are available only on limited regions of the sky, for certain spectral types or only for very bright stars (i.e. V~7.5 for Hipparcos).

Trilegal simulated CMD of 10 deg^2 at b=20, V<11.
Suitable Plato targets are within the blue box



At the present time, an all-sky classification of faint stars (8<V<13, samples P1&5) has to rely only on **broad-band magnitudes** and **proper motions**.

Available and forthcoming catalogs

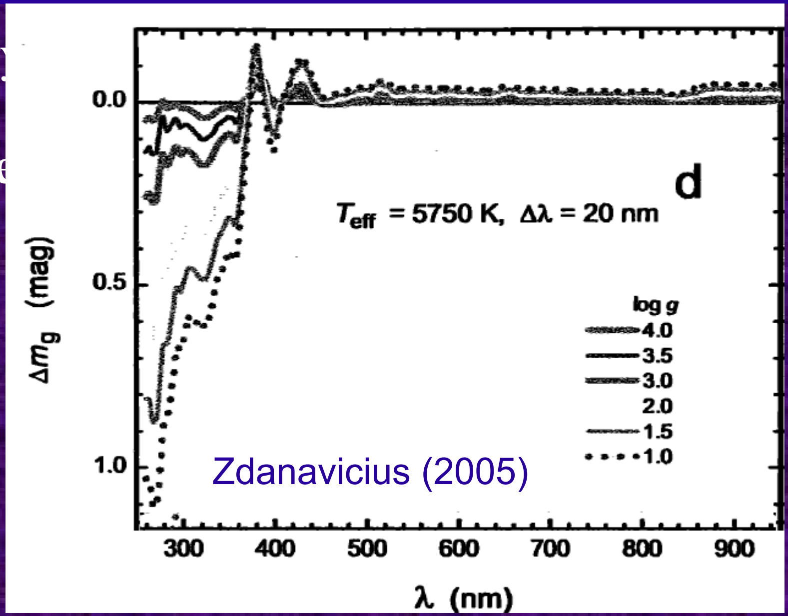
NAME	coverage	released	V_{lim}	V_{sat}	bands	σ_{phot} (mag)	σ_{xy} (mas)	P.M.	notes
Hipparcos	100%	yes	8		H_p	0.001-0.002	1-3	yes	parallaxes
Tycho-2	100%	yes	11		$B_T V_T$	0.013-0.1	7-60	yes	
USNO-A2.0	100%	yes	20	11	$\sim BR$	0.3	250	no	
USNO-B1.0	100%	yes	21	11	$\sim BRI$	0.3	200	yes	
GSC 2.3	100%	yes	20	11	$B_j R_f I_N V$	0.13-0.22	200-300	yes	
UCAC3	100%	yes	16		wide	-	15-20	yes	only astrometric
2MASS	100%	yes	17	7-8	JHK_s	0.01-0.15	70	no	
SDSS	25%	2016	22		*ugriz*	0.02-0.03	100	yes	+spectra
APASS	15%	?	17		$BVg'r'i'$	0.01-0.03	100-250	no	
ASAS/AASC	>50%	partial	14		VI	0.05-0.1	-	no	variability survey
Skymapper	-	?	16-23	8-9	$ugriz + v_s$	0.03	50	?	only South
PAN-Starrs	-	2013	24		wide + *griz*	0.01	70	yes	only North
LSST	-	2017	24		*ugrizY*	0.01	20	yes	only South
Gaia	-	2015 (ER)	20		LR spectra	<0.01	0.02	yes	plx, RV, spectra

- 2MASS provides accurate (dm~0.01 mag) all-sky NIR photometry down to V~16
- Tycho-2 provides accurate all-sky B,V photometry and astrometry down to V~11.5
- UCAC3 provides accurate astrometry (PM) down to V~16.

No accurate all-sky VIS photometry is currently available for V>11.5

What can we do only with the available catalogs?

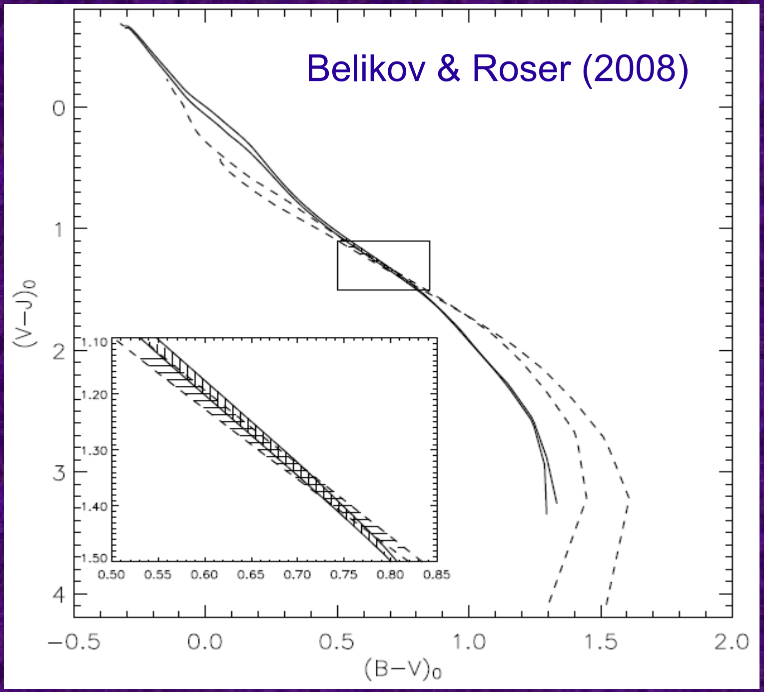
Classification from broad-band photometry



Deriving stellar parameters from broad-band photometry is challenging, as the effects of gravity on colors are **small** (few 0.01 mag typically) and strongly **degenerate** with reddening and metallicity on some regions of the parameter space.

Many attempts have used Tycho-2 $B_T V_T$ and 2MASS *JHK* magnitudes as input:

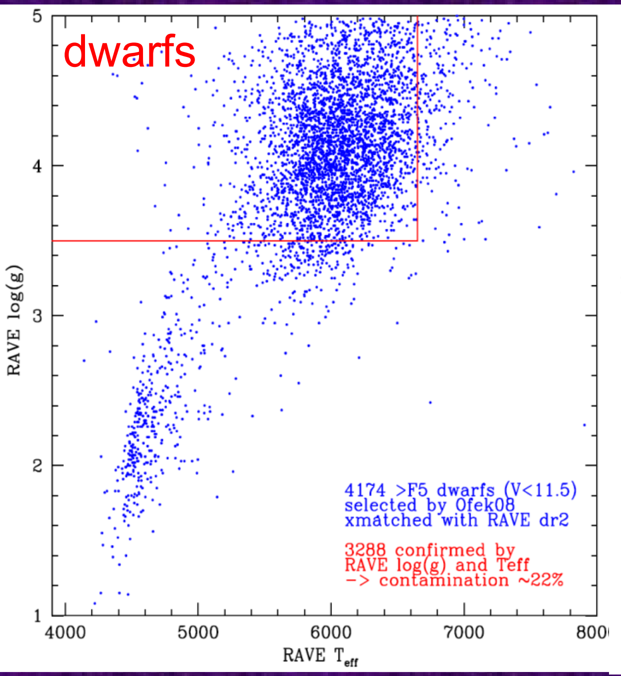
- **Ammons** et al. (2006): fitting of spline functions of *BVJHK* colors and proper motions, using the Hipparcos catalog as training set
- **Ofek** (2008): SED fitting of *BVJHK* magnitudes with the Pickles (1998) spectral library.
- **Belikov & Roser** (2008): fitting of synthetic extinction-free *Q*-values on *BVJHK* photometry, calibrated on a subset with spectroscopical info.
- **Bilir** et al. (2006): linear fit of "*V*"+*JHK* mag-mag diagrams with a spectroscopical training set (*V* band from various and unspecified sources)



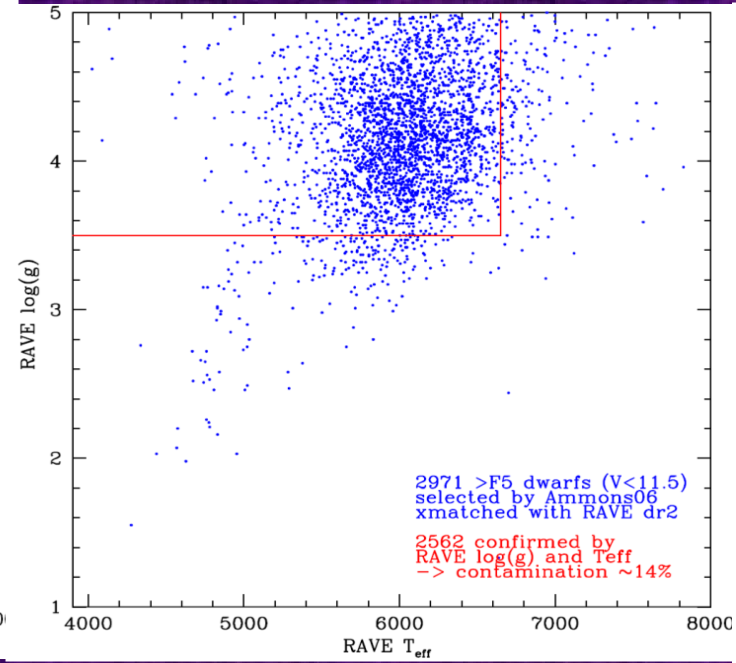
Completeness/Mis-classification issues

- As pointed out by Klement et al. (2010), **the misclassification of a sample of dwarfs classified by broad-band photometry is typically around 20%**: a lower contamination can be achieved only decreasing the completeness to unacceptable levels.

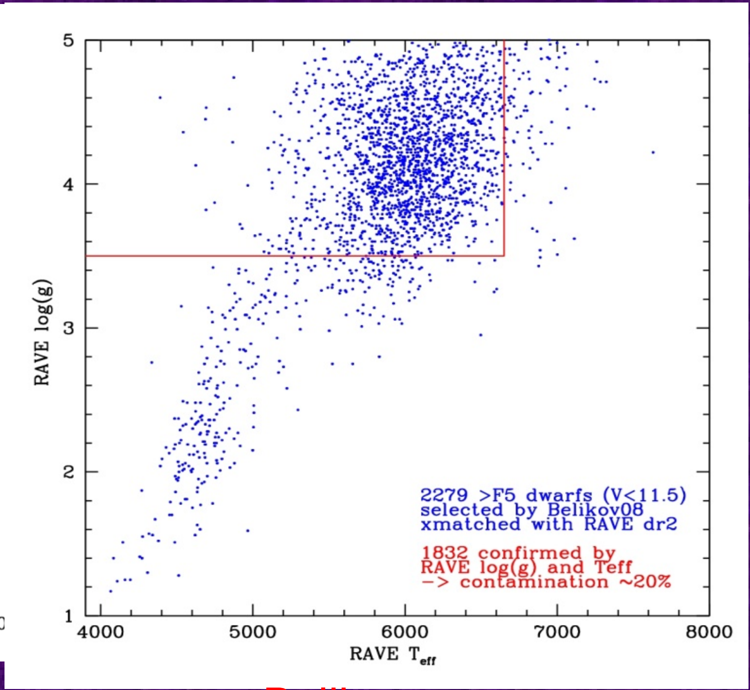
We matched the Ammons, Belikov, and Ofek databases with the RAVE dr2 spectroscopical survey – confirming Klement: **~14%, ~20%** and **~22%** of late dwarfs classified by photometry show log(g) and *T*eff are probably giants or earlier dwarfs.



Ofek



Ammons



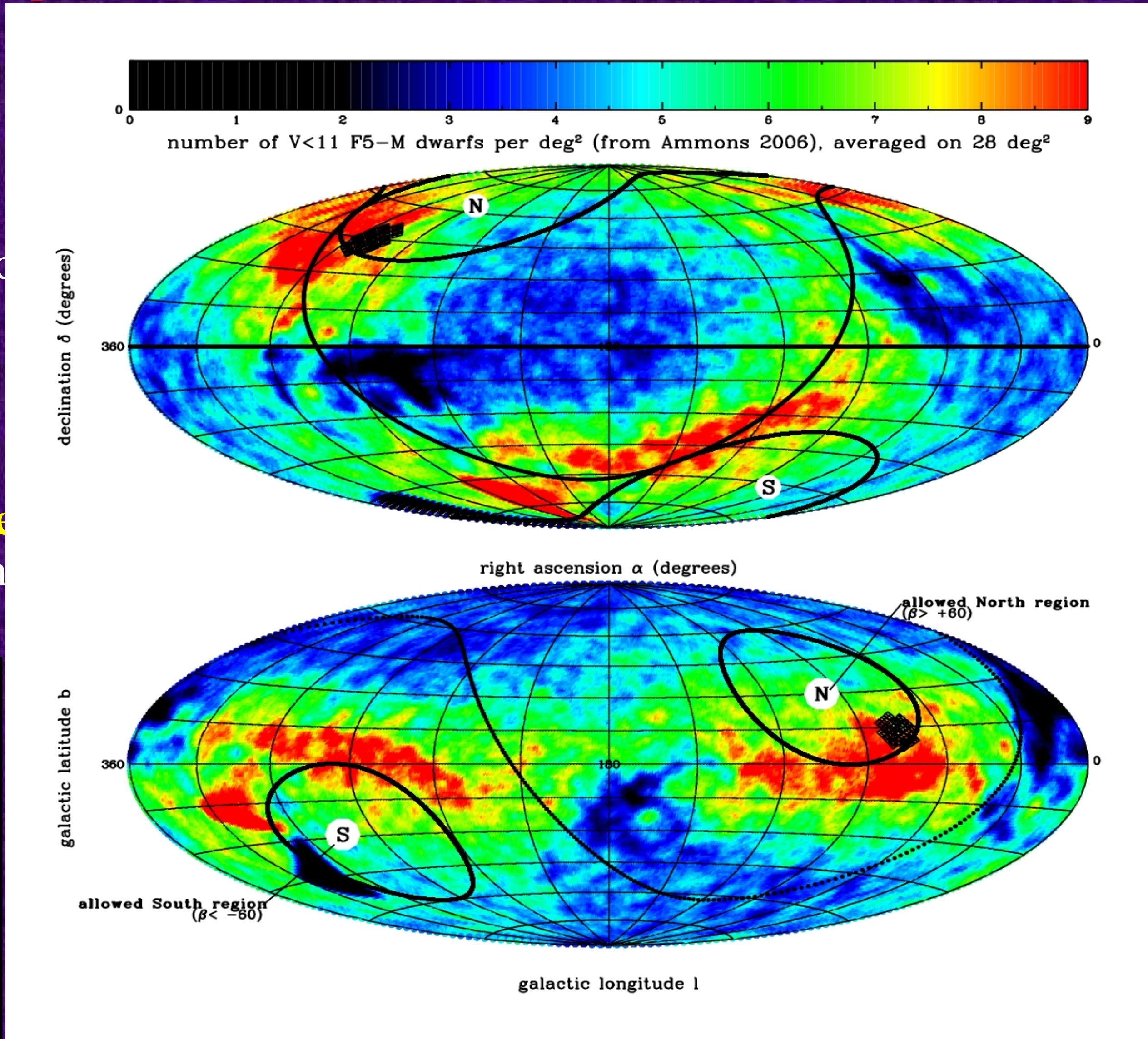
Belikov

Target density maps

The biggest issue when dealing with broad-band classifications is that (so far) they rely on Tycho-2 for *BV* magnitudes: the **completeness is limited to *V*~11**.

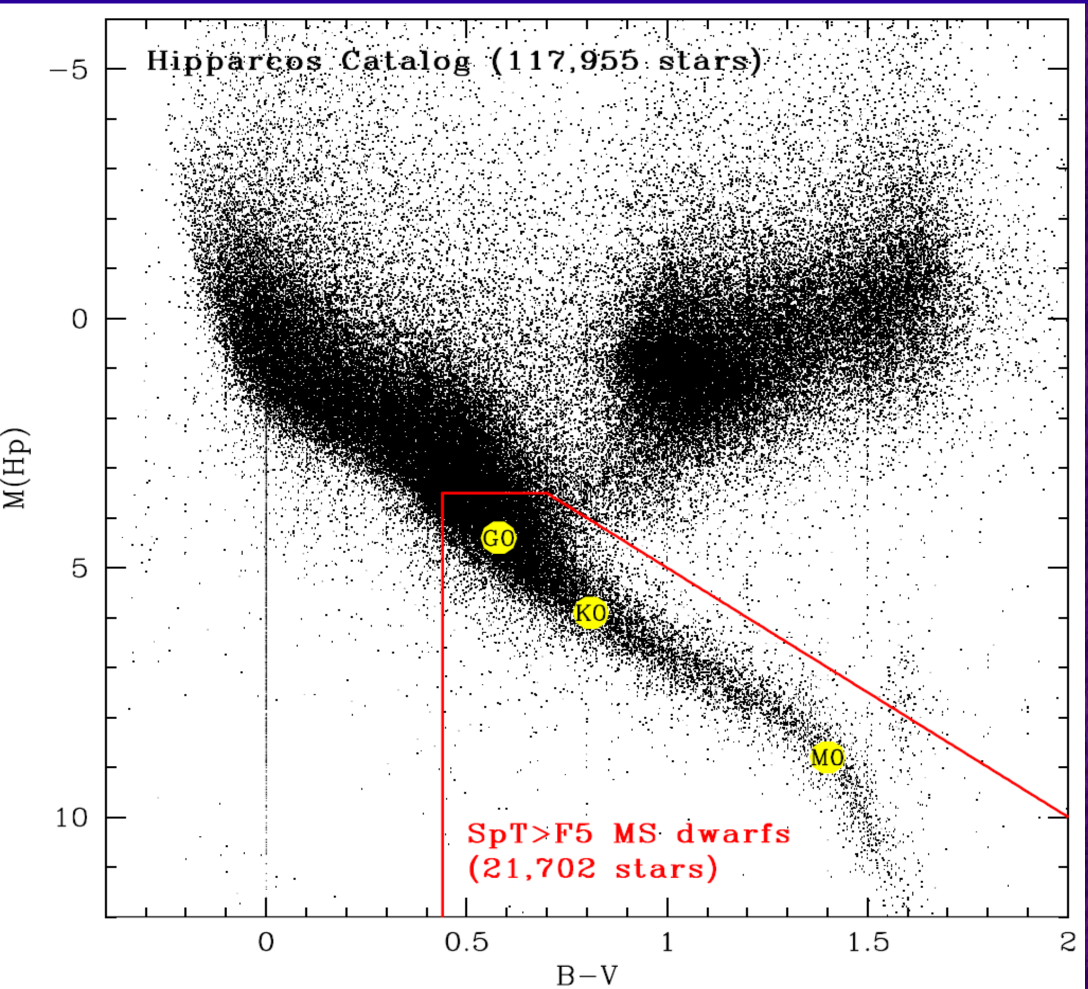
However, the **brightest samples** (P1, P2, P3, *V*<11) are the most scientifically rewarding and they will drive the choice of the LD Plato fields.

Using databases from Ammons, Belikov, Ofek, etc. we can extract only the >F5 dwarfs and build **targe density maps** to see if and where th requirements are met.

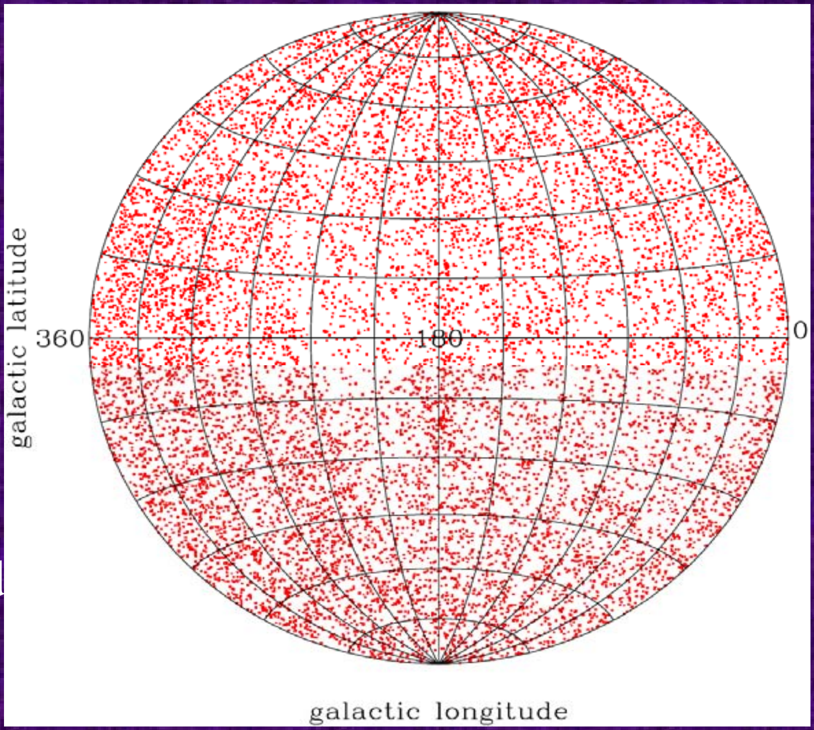


As expected, the late-type dwarfs with V<11 are not strongly concentrated toward the disk, their density varying only by a factor ~2. This is because they are all within ~800pc from the Sun

Sample P2 (*V*<8): Hipparcos



- The Hipparcos catalogue provides reliable parallaxes down to *V*=7.3 (completeness limit) but includes also most of *V*<8 stars.
- We selected >=F5V dwarfs and subgiants by a simple cut on the absolute CMD, to pose a **lower limit** to the number of potential targets in the Plato stellar sample P2 (~500/PF are required)



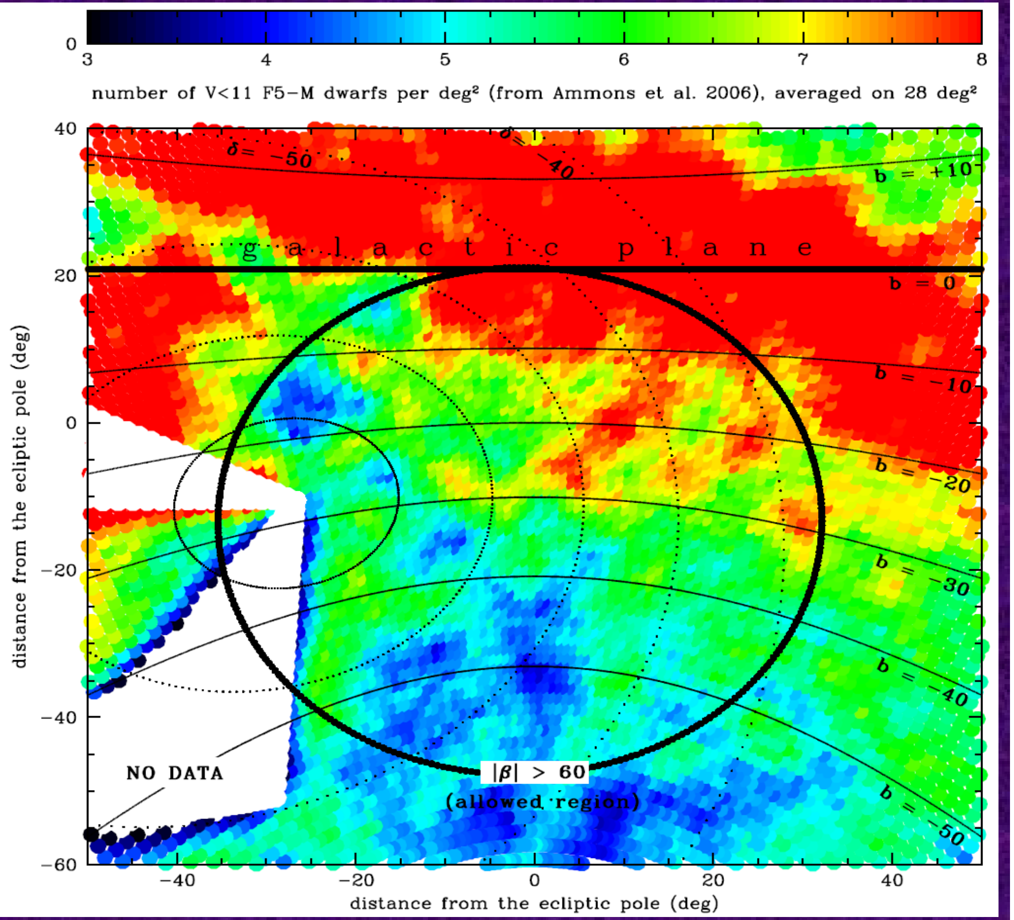
The ~22,000 selected targets are uniformely distributed across the sky (as expected), giving a density of ~0.5 stars/deg^2 ► ~1000 targets for each 2200 deg^2 Plato Field not dependent upon the chosen FOV.

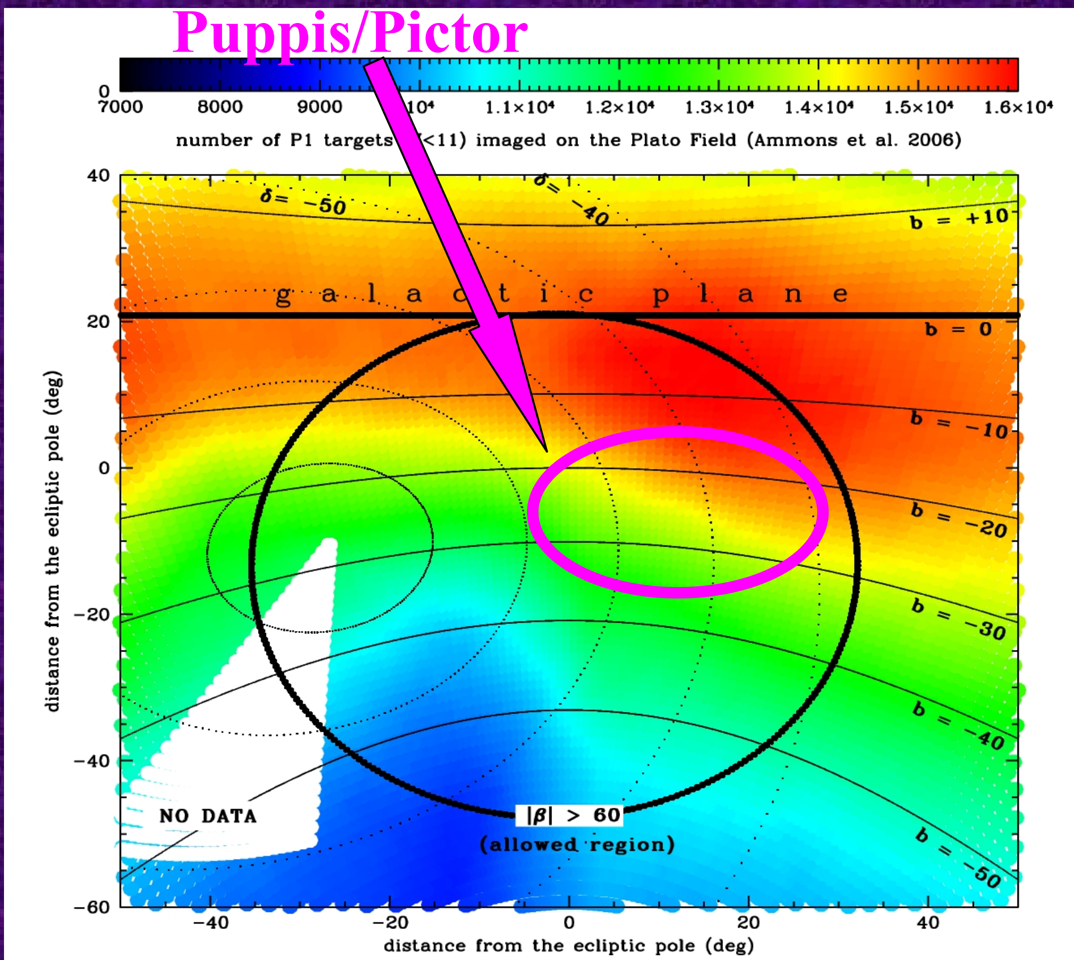
P1 target densities for the Plato Field South

The southern region shows an overall density of P1 targets ranging from 4 to 9 star deg^{-2}. (Ammons06)

By summing the counts over the 2200 deg^2 Plato Field and taking into account a ~30% contamination, the requirement of 10,000 P1 targets/field is met on ~30% of the observable region.

For *l* < 270 (δ > -60) the requirement is met positioning the center of PLATO field down to *b* = -30!

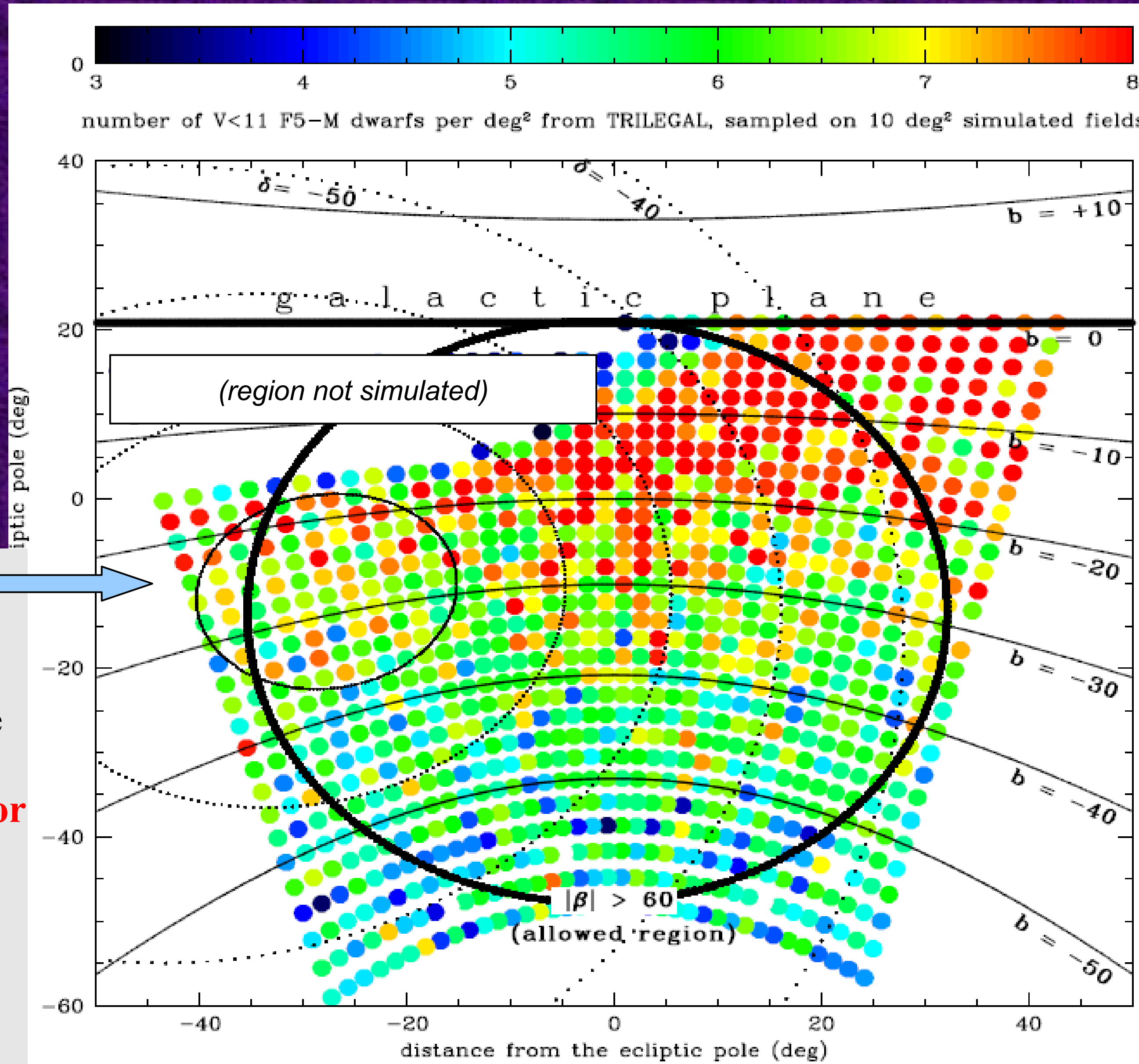




Galactic Models: TRILEGAL & Besançon

As independent check, also **Galactic models** such as **Besançon** (Robin et al. 2003) and **TRILEGAL** (Girardi et al. 2005) can be used to calculate the expected density of targets as function of the galactic coordinates.

Warning: both models are known to be unreliable when simulating fields near to the galactic plane (*b* <~ 10)!

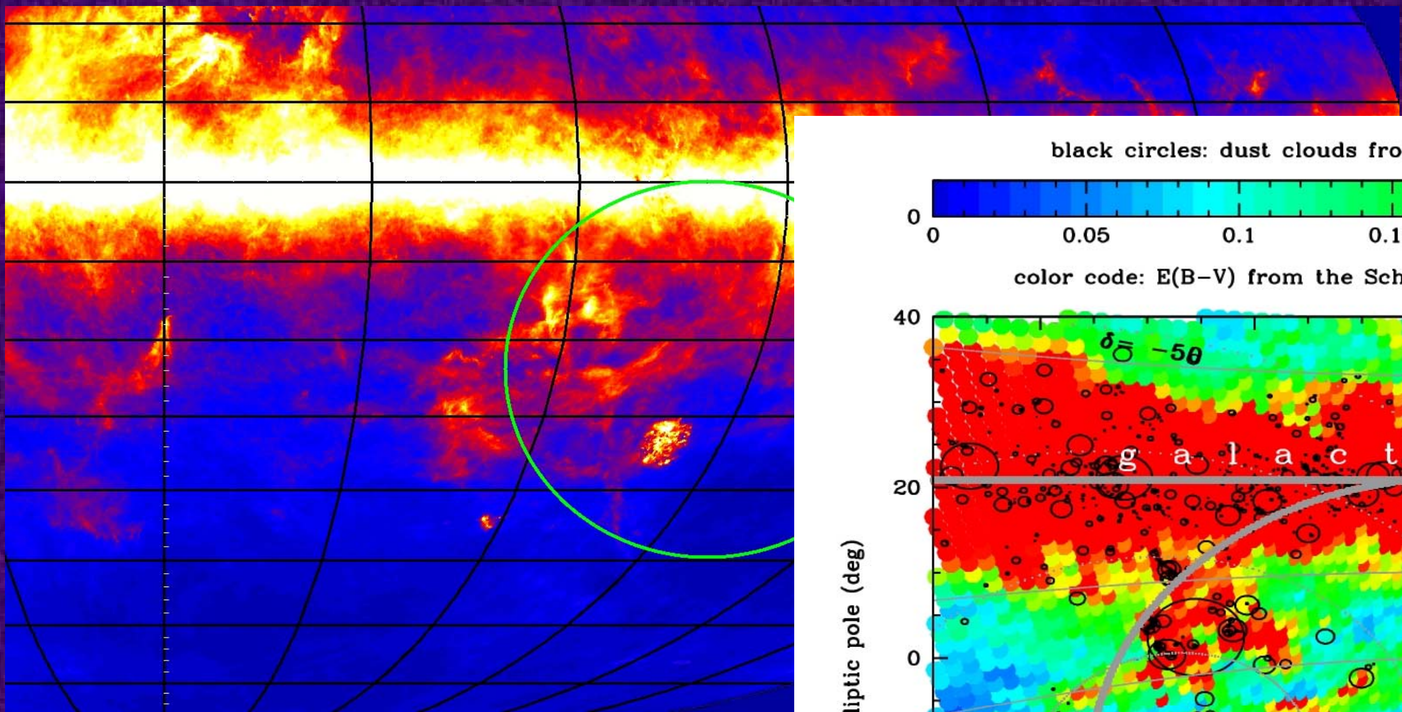


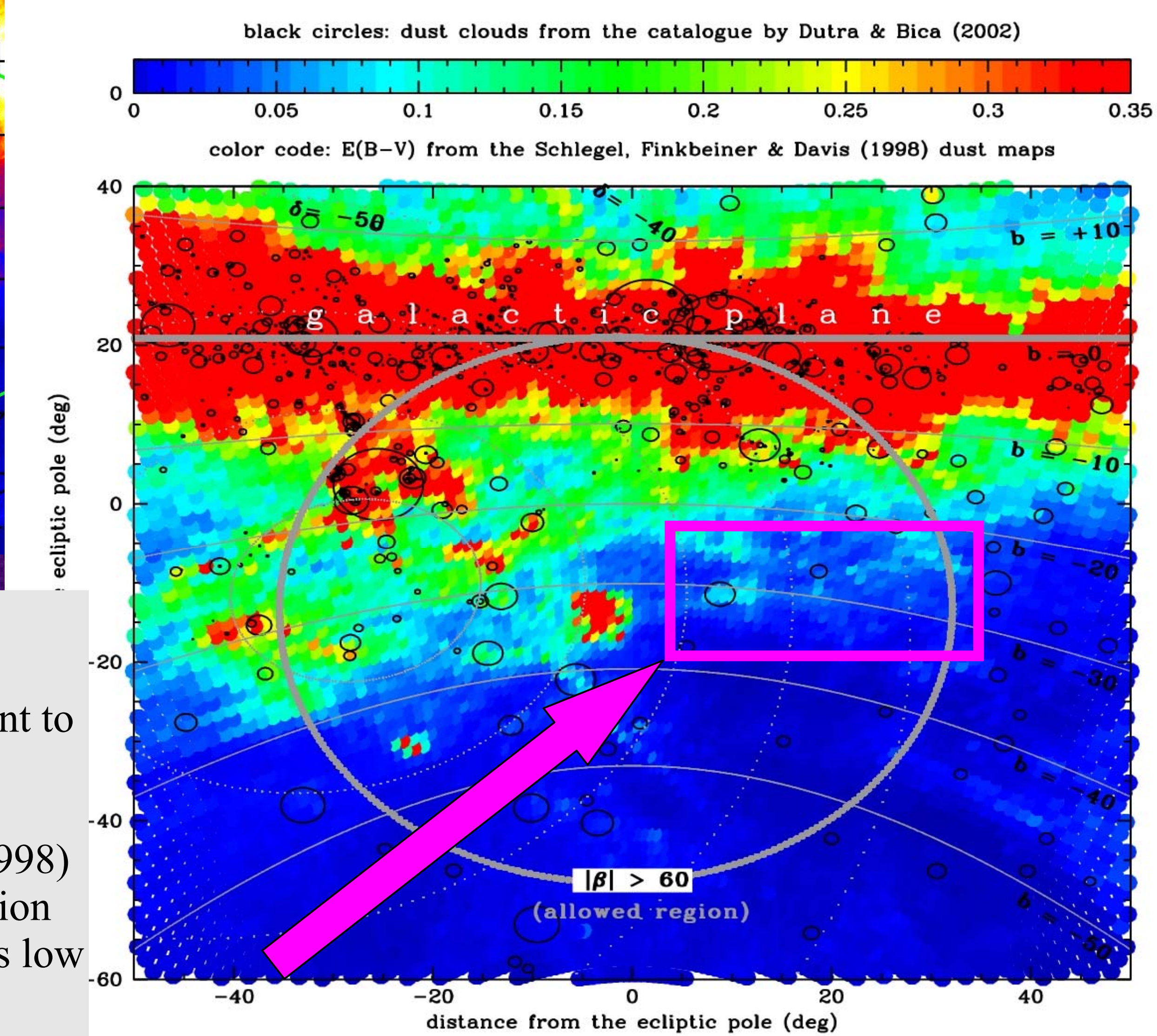
We simulated with the a grid of synthetic fields over the southern allowed region:

The counts for the **P1 (*V*<11)** meet the conservative requirement of 5*/deg^2 (=11,500 */field) about **everywhere for |b|<50**.

P5 (*V*<13.5) targets meet the requirement of 110*/deg^2 (=245,000 */field) **for |b|<30**.

Reddening from dust maps

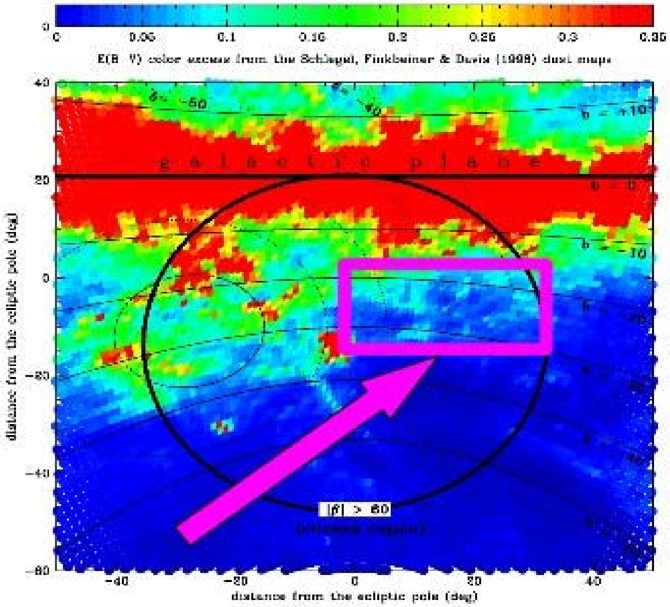


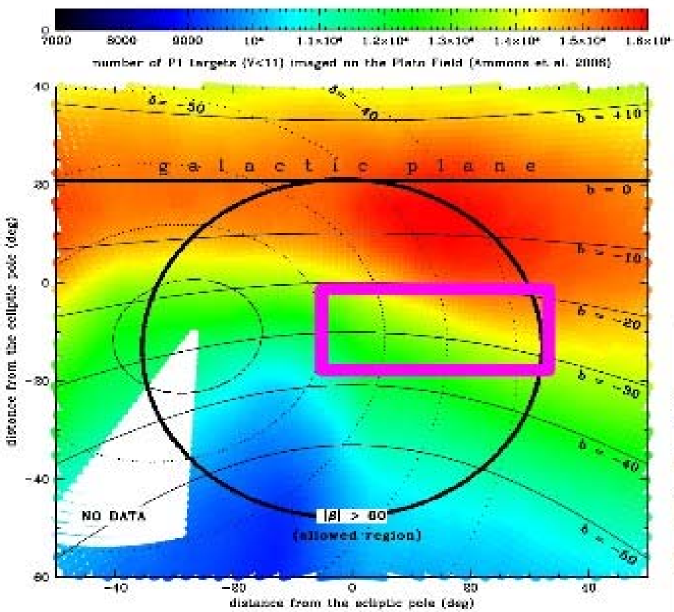


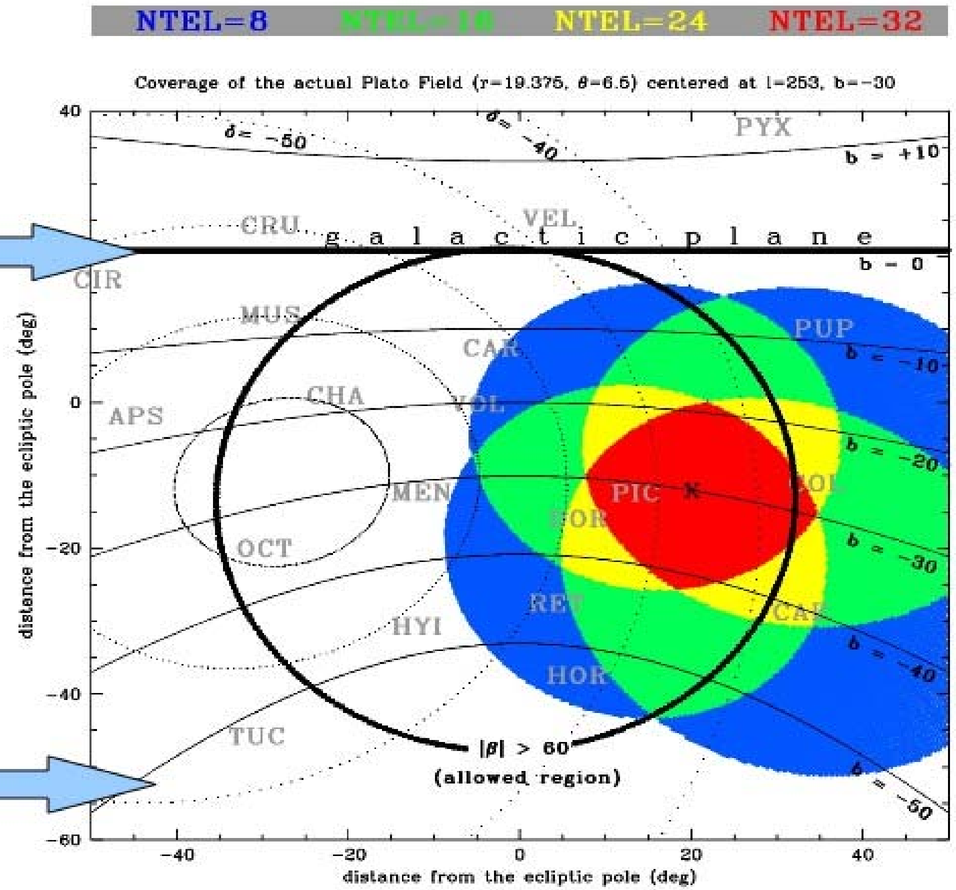
Since **reddening** is a source of errors for photometric classification techniques, we want to avoid as much as possible "dusty" regions.

Following the dust maps by Schlegel et al (1998) and Dutra & Bica (2005), we identified a region with b~**-30** where the interstellar extinction is low (l<270, delta>-60)

The proposed 1st Plato Field







Following the need to satisfy the P1-P5 requirements (b>-30, l<270), to avoid as much as possible the galactic plane (crowding+contamination), to minimize the reddening: **we propose l=253, b=-30 (in Pictor) as center of the first Plato long-duration FOV**.

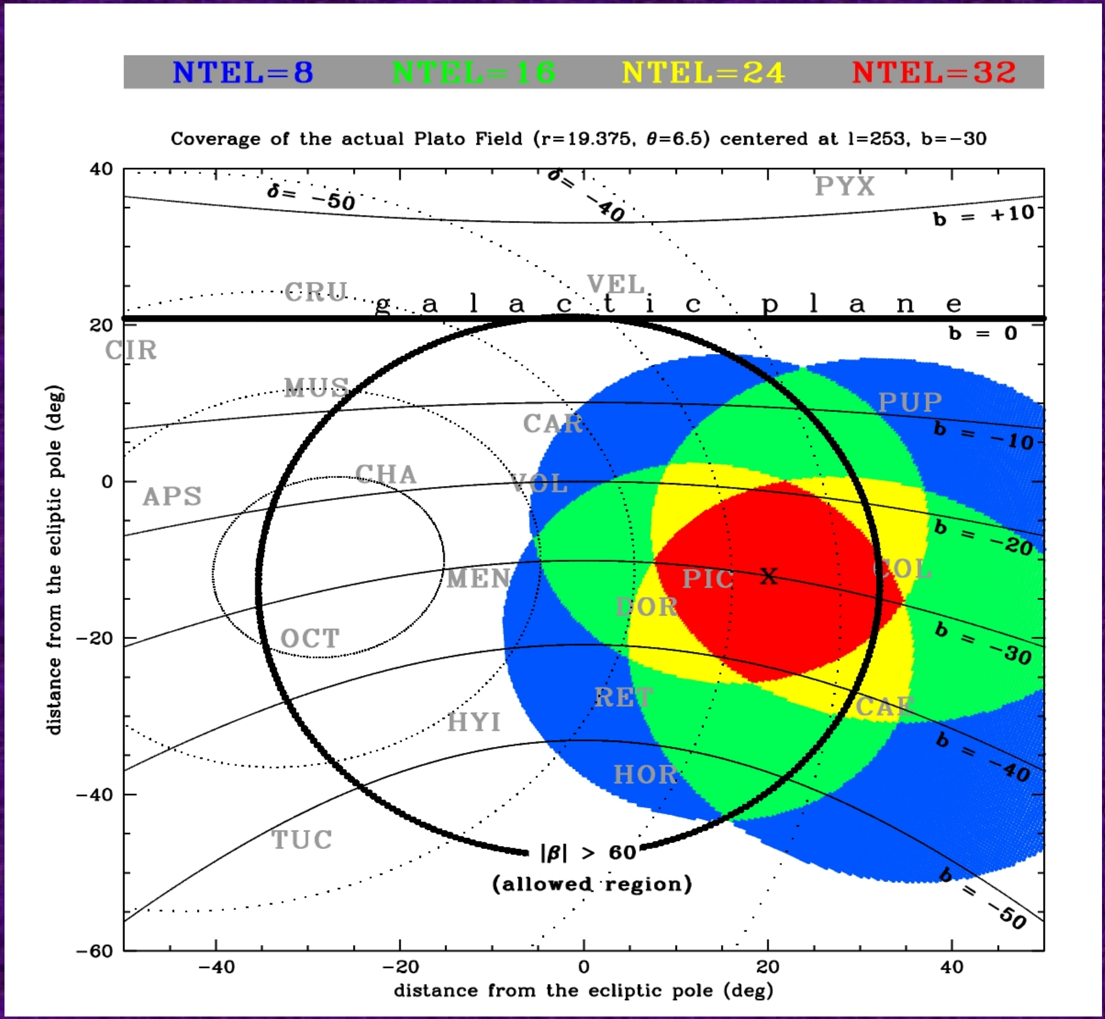
The proposed 1st Plato Field

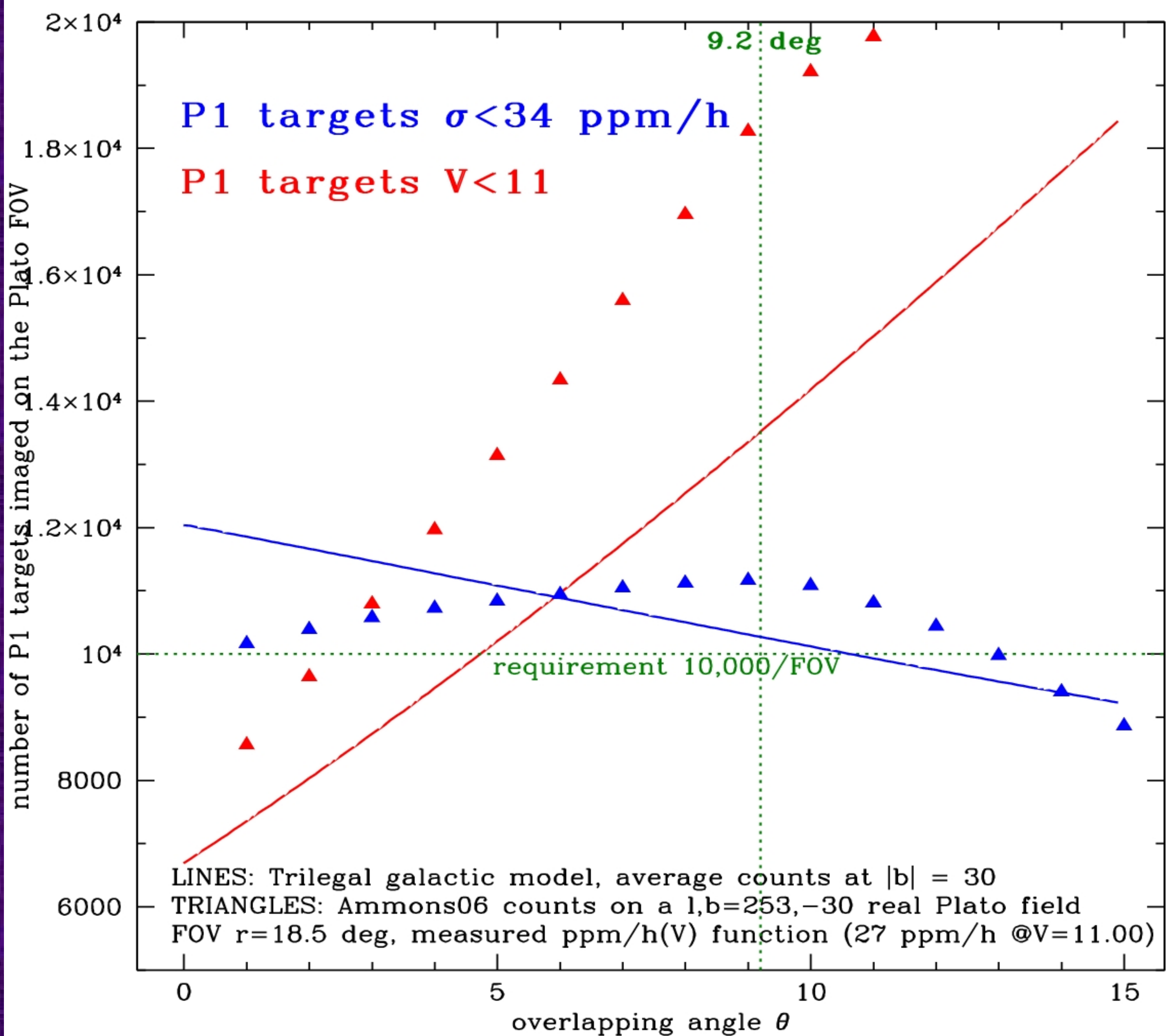
l = 253, b = -30,
α = 5h 47m, δ = -46 26
(in Pictor)

1) >5 deg from the Galactic plane, most of the field **avoids regions with extreme stellar crowding**; the area covered by >8 telescopes is mostly in low-extinction regions

2) both **requirements for 10,000 P1 targets and 245,000 P5 targets are met** (conservatively) according to both photometric classifications and galactic models

3) the field is in the south emisphere, mostly at δ > -60 → **easy to be observed with the southern facilities**

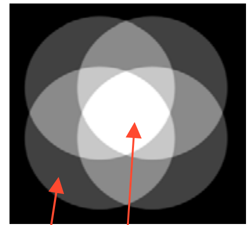




9.2 deg
P1 targets σ<34 ppm/h
P1 targets V<11
requirement 10,000/FOV
LINES: Trilegal galactic model, average counts at |b| = 30
TRIANGLES: Ammons06 counts on a l,b=253,−30 real Plato field
FOV r=18.5 deg, measured ppm/h(V) function (27 ppm/h @V=11.00)
number of P1 targets imaged on the Plato FOV
overlapping angle θ
2×10⁴
1.8×10⁴
1.6×10⁴
1.4×10⁴
1.2×10⁴
10⁴
8000
6000
0
5
10
15

Expected performances

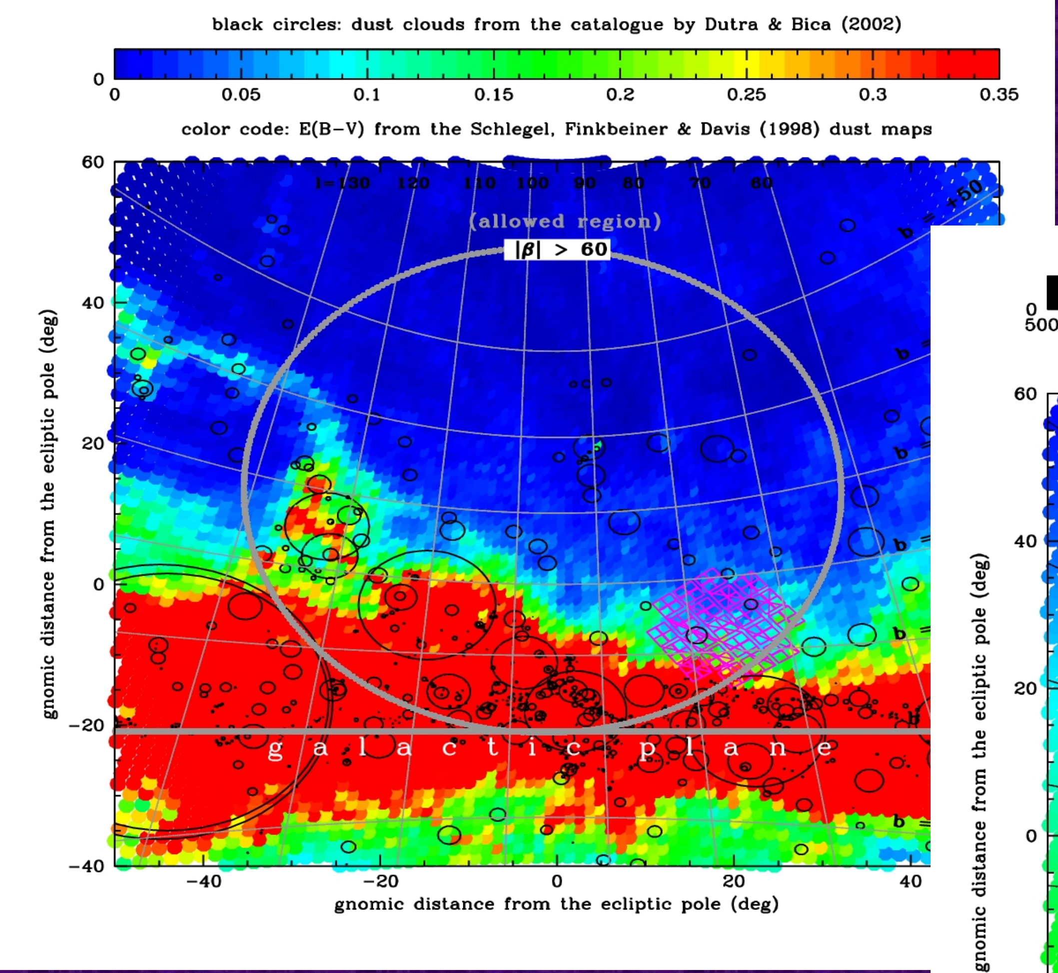
as a function of noise level

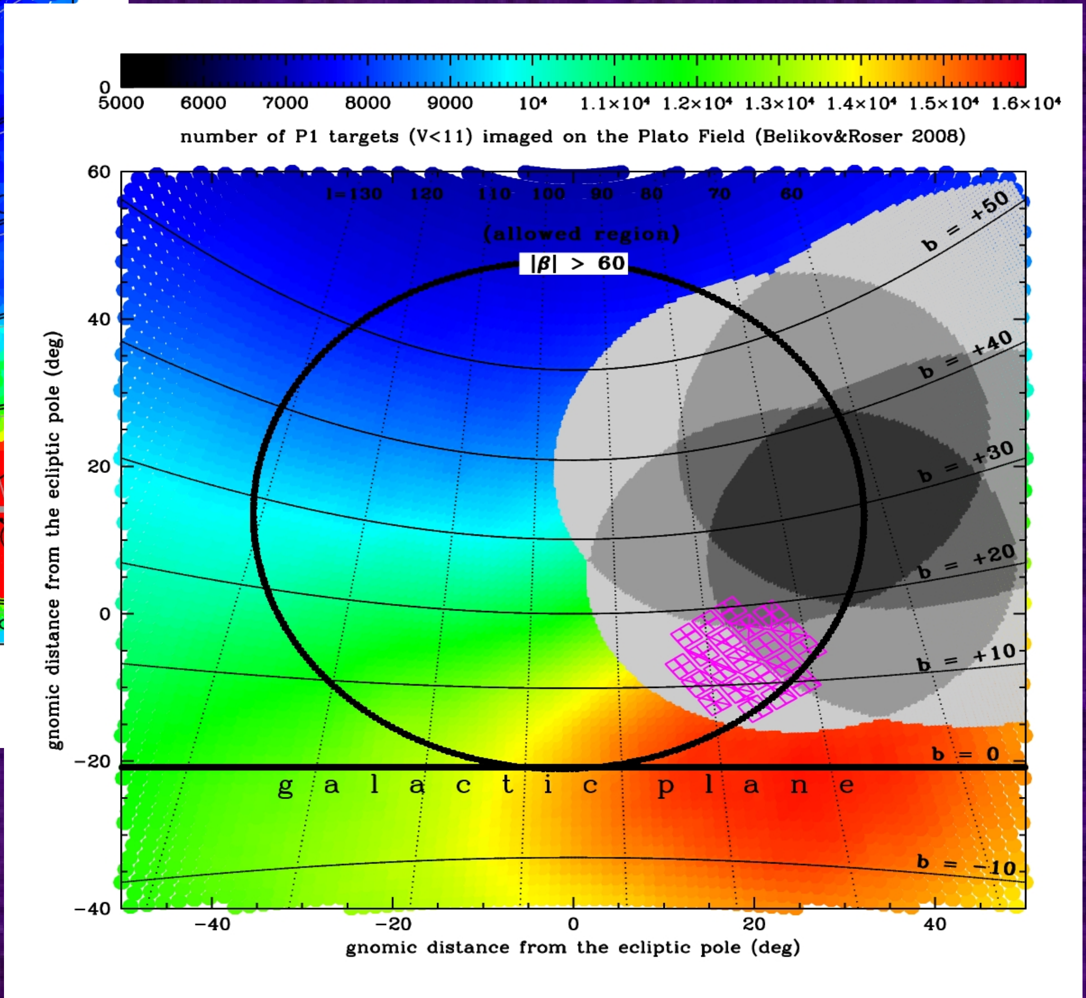


	PLATO (4300 deg^2)		20,000 deg^2	KEPLER (100 deg^2)	
noise level (ppm/√hr)	nb of cool dwarfs & subgiants long monitoring	m_V	nb of cool dwarfs & subgiants incl. step&stare	nb of cool dwarfs & subgiants	m_V
27	15,000	9.3 - 10.8	60,000	1,300	11.2
34	**22,000** 20,000	9.8 - 11.3	88,000		
80	292,000 245,000	11.6 - 12.9	1,000,000	25,000	13.6
	1,326 1,000	8	**5000** 3,000	30	8
	60,275	11	180,000	1,300	11

as a function of magnitude

Possible northern field: l=65, b=30 (Hercules)





M-dwarfs sample (P4)

CONSIDERED "ALL-SKY" CATALOGS:

- **TYCHO**
  magnitude V<11.5 → too bright
- **SDSS**
  saturation at r=15 → too faint for PLATO
- 2MASS
  JHK band, average photometric accuracy: 5%
  deep down to K=15, completeness 99%
- UCAC3
  single bandpass between V and R
  range=[8-16] mag
  average proper motion accuracy: 1-10 mas/yr

→ **2MASS & UCAC3 CATALOGS**
A RELIABLE GOOD TOOL:
63% efficency; 30% contamination

On purpose surveys for PLATO target identification and characterization are under investigation

Photometric:

Using Super-WASP facilities (robotic telescope, 14 arcsec/pixel, 7.8x7.8 sq deg field, to be equipped with narrow intermediate/narrow band filters)

Using RobTel (AIP, 80cm, 0.5 sq deg field, equipped with Stromgren filters)

Spectroscopic:

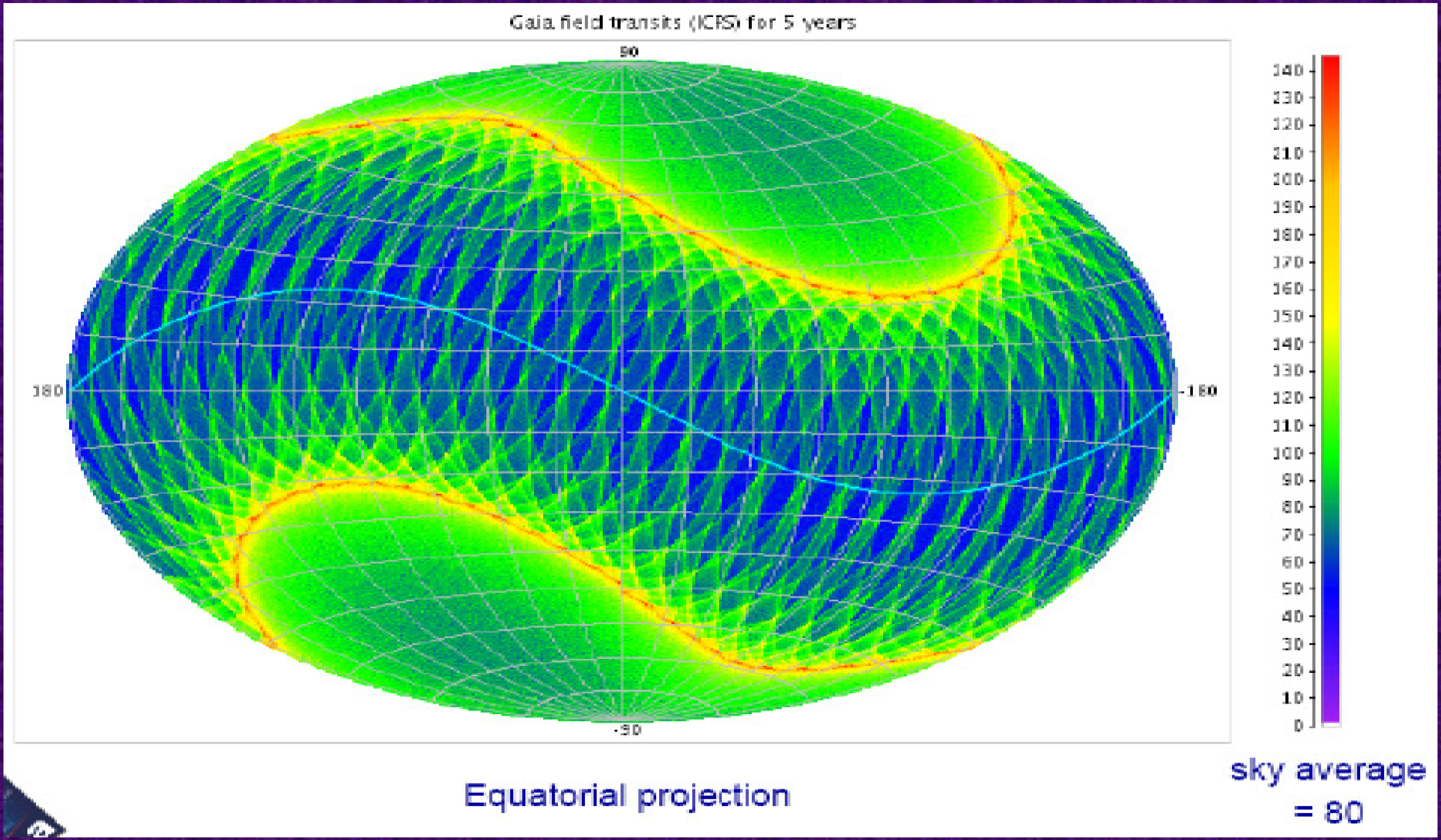
Extension of RAVE survey

How Can GAIA Help PLATO?

Two main issues we started to address:

- Crowding
- Scanning Law

Is the scanning law a problem?



It might be, in particular for the early release catalog data.
It depends on the selected PLATO fields

How Gaia can help PLATO

- We started an assesment study on what Gaia can provide for the PIC after the first 18 months of mission (Early Release Catalog).

- We will use some tools developed by the DPAC (Gaia Consortium) to get a reliable estimate of the Gaia measurements and accuracies (parallax, star parameters,...), and use them for PIC purposes (agreement reached, first simulations provided)

- **Note that there is still time to define the early release catalog parameters. We need to assess what PLATO needs from GAIA ERC and discuss this with GAIA team.**

- **GAIA output data and accuracy estimate shall be used to develop tools for the identification of PIC targets and their basic parameters**

	type	list	origin
1	position	RA, DEC, proper motion	photometric catalogs
2	observed magnitudes	magnitudes in visible and NIR filters	photometric catalogs
3	parallax, astrometric motion		Hipparcos and GAIA
4	atmospheric parameters	Teff, logg, metallicity, spectral type	derived from photometric catalogs and spectroscopic archives
5	abundances	individual elements, Lithium	spectroscopic archives
6	fundamental parameters	mass, radius, age	derived from atmospheric parameters and evolution tracks
7	background	RA, DEC, magnitudes of contaminants	photometric catalogs
8	nature	multiple systems, planetary systems, cluster member, disks	archives TBD
9	activity	Xray flux, spot modulation, spectroscopic indices	Xray, spectroscopic, and photometric catalogs
10	asterosismology	??	??

selection

characterization

Please, contact Claire Moutou