The Roman Galactic Plane Survey and How It Can Be Used to Expand on Microlensing (and Transit) Surveys

Roberta Paladini (Caltech/IPAC)

A Community-defined Roman Galactic Plane General Astrophysics Survey

- ✓ In 2021 the Roman Project released a Request for Information to the science community to solicit comments on (a) whether to select an Early-Definition General Astrophysics Survey, and (b) to outline and submit survey concepts that would demonstrably benefit from selection as an Early-Definition General Astrophysics Survey.
- ✓ Twenty complete submissions were received with over 340 unique authors.
- ✓ The top-ranked concept was a survey of the Galactic plane (Sanderson et al. 2024).
- ✓ Accordingly, a community-defined Roman Galactic Plane General Astrophysics Survey, of up to approximately 700 hours, was defined by a committee of community members.
- ✓ There were no mission level science requirements on a Roman Galactic Plane Survey, leaving the full parameter space available to define the observational strategies (filters, depth, cadence, etc.) in a way that enabled a broad range of astrophysical investigations.

Roman Galactic Plane Survey
Definition Committee Report

Aug 18, 2025

Committee Members:

Robert Benjamin, University of Wisconsin-Whitewater (ret) [Co-chair]
Rachel Street, Las Cumbres Observatory [Co-chair]
Rachael Beaton, Space Telescope Science Institute
Sean Carey, Caltech-IPAC
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Roman Liaisons to Committee:

Andrea Bellini, Space Telescope Science Institute
Dario Fadda, Space Telescope Science Institute

Contributors:

Numerous colleagues have contributed to this report, as will be noted throughout the document, but the committee would like to specifically highlight three groups of contributors:

(1) the authors of white papers and science pitches described in this report[1],
(2) the participants and Scientific Organizing Committee of the *Roman Galactic Plane Survey Community Workshop*[2] held online on Feb 11-13, 2025, and
(3) the participants, Local Organizing Committee, and Scientific Organizing Committee of the *Galactic Science with the Nancy Grace Roman Space Telescope* workshop held at Yerkes Observatory on June 13-15, 2024.[3,4]

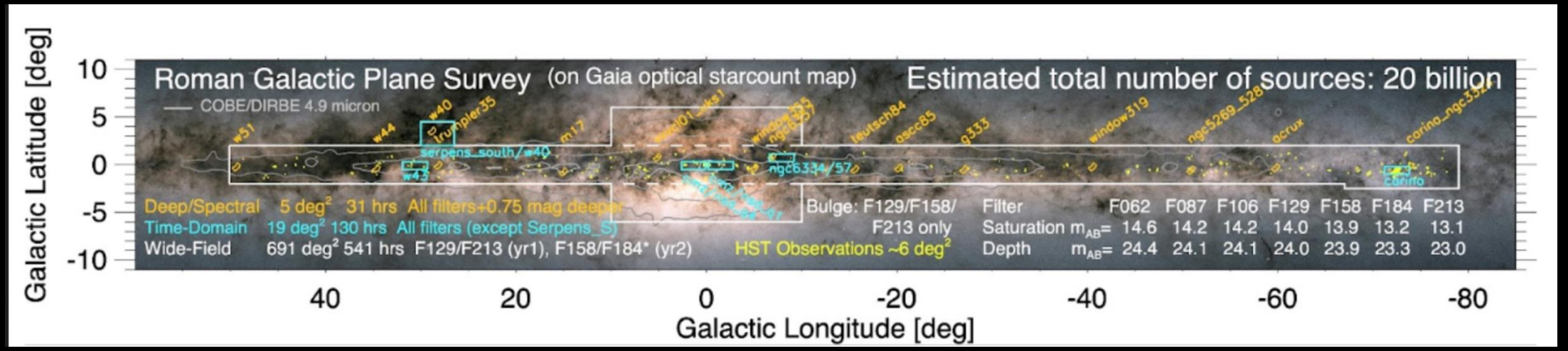
Copies of contributed presentations, manuscripts, and minutes of numerous discussion groups may be found in the links below. The Definition Committee was extremely grateful for the interest and support of our colleagues and for their many contributions to this survey, and it is our hope that the program presented here will provide data of value for science programs for many decades to come.

[1] https://stsci.app.box.com/s/4wchza9b8q3nmajaqazkuzb5kxhkmqbc
[2] https://outerspace.stsci.edu/display/GPSCW/Galactic+Plane+Survey+Community+Workshop+Home
[3] https://sites.google.com/cfa.harvard.edu/romanyerkes/home
[4] https://tinyurl.com/roman-yerkes-discussions

The Roman Galactic Plane Survey Definition Report:

https://science.nasa.gov/mission/roman-space-telescope/galactic-plane-general-astrophysics-survey

The Survey in a Nutshell



Wide-field mapping - 691 deg², 541 hours	**Time-domain - 19.1 deg², 130 hours**	**Deep-field/Spectroscopic - 4.8 deg², 30 hours**
Covering a large, continuous portion of the Galactic plane (Galactic latitude $\|b\|<2$ deg and Galactic longitude l = 50.1 - 281 deg) with higher latitude extensions for the bulge, Serpens South/W40 star formation region, and Carina	Six fields including the full Nuclear Stellar Disk (NSD) and Central Molecular Zone (CMZ)	Fifteen pointings over a wide range of extinction, diffuse emission, stellar density, and populations
Four filters: F129, F159, F184, F213	Seven filters: F062, F087, F106, F129, F158, F184, F213	Seven filters: F062, F087, F106, F129, F158, F184, F213
	Repeat observations in one or more filters with cadences from ~11 minutes to weeks	Longer exposure times (with respect to time-domain element) and grism and prism observations

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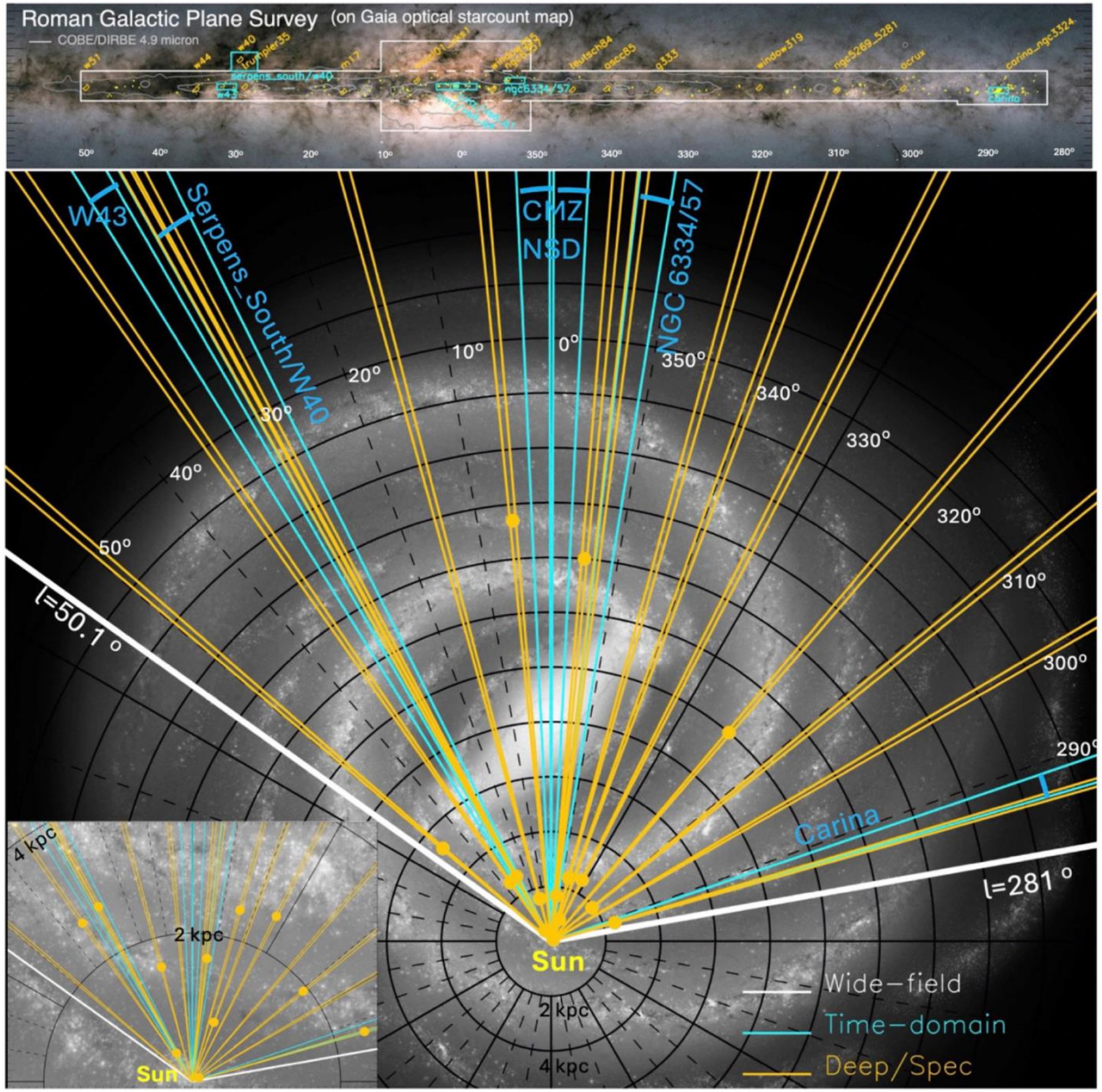

Figure 2.2 [top] RGPS survey outline showing the wide-field (white), time-domain science (cyan), and deep/spectroscopic science (orange) fields on a Gaia starcount image with COBE/DIRBE 4.9 micron contours showing the stellar disk/bar. [bottom] Survey directions shown on a face-on representation of the Milky Way by R. Hurt. The distance to "objects of interest" (labeled in the upper panel, and listed in Table 4.4) in each Deep/Spectroscopic field are shown. An inset shows a blow-up of these sightlines within 4 kpc of the Sun.

Roman repeated observa d observations become compromised due to sou

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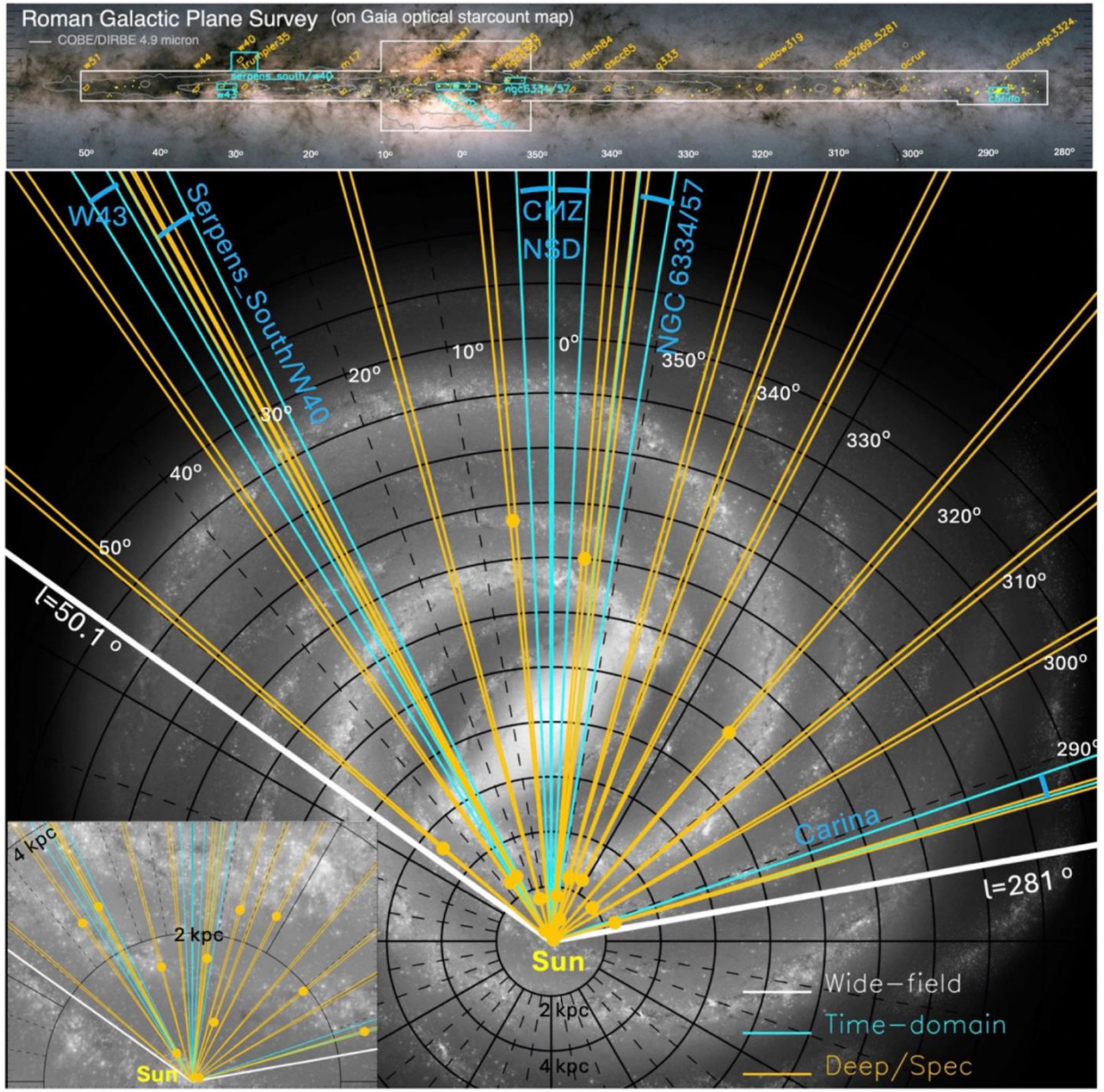
- ➢ Weekly cadence:
  - Central Molecula



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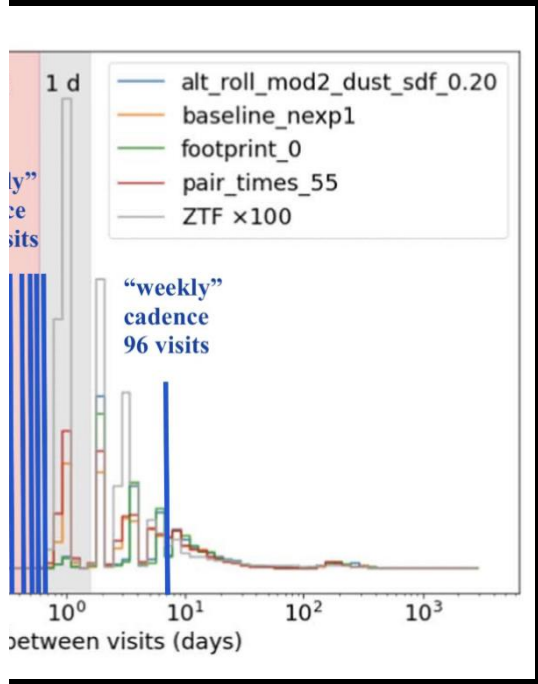


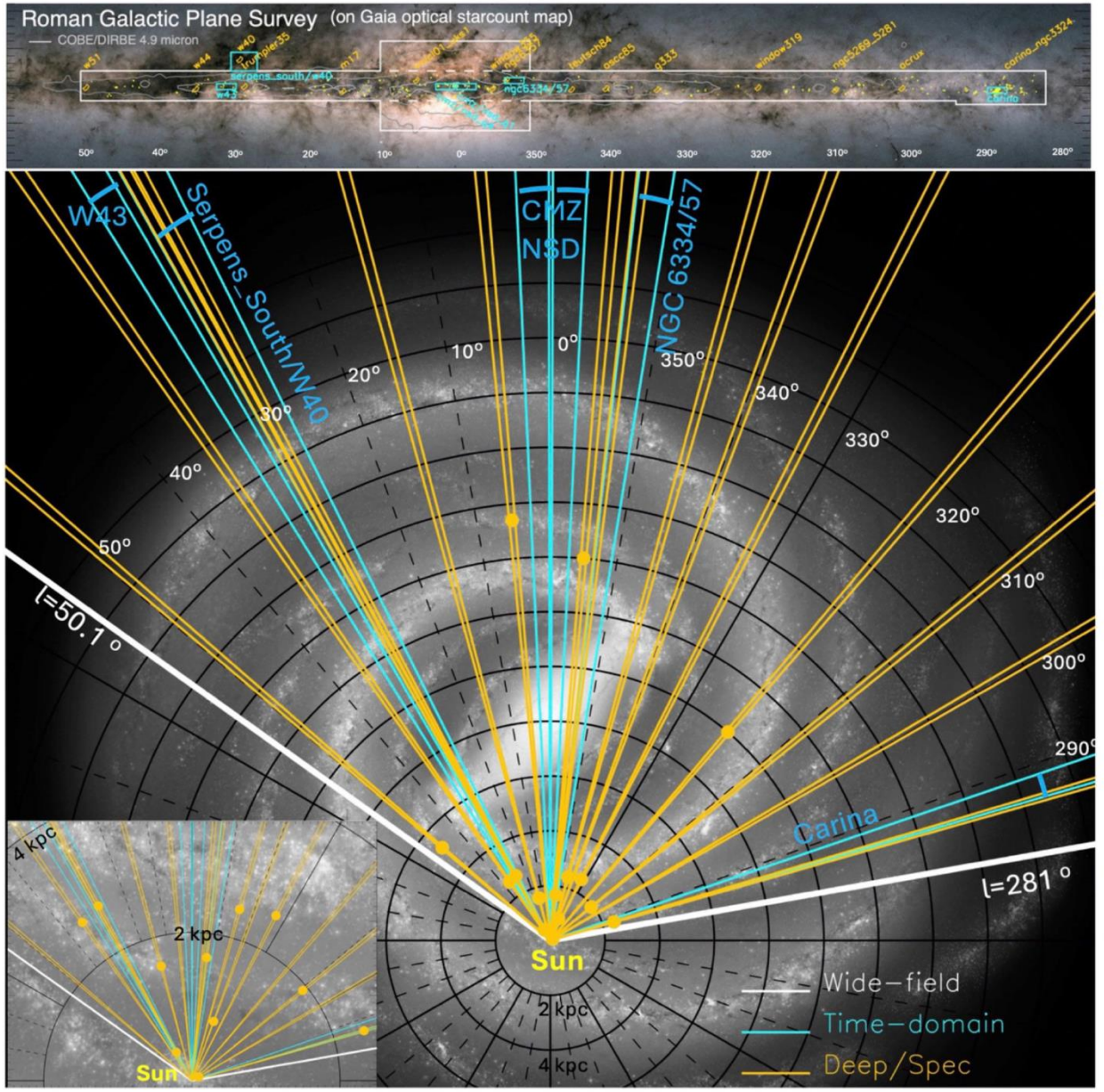
Modified from Bellm et al. (2022)

II. ey

- Roman grism: wavele
- Roman prism: wavele

Advantage → Provide th rge number of sources
Challenges → from guic ctral traces

- Fourteen a range of stellar de sion
- A fifteenth ric depth and prism obs



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Summary of the RGPS Observations

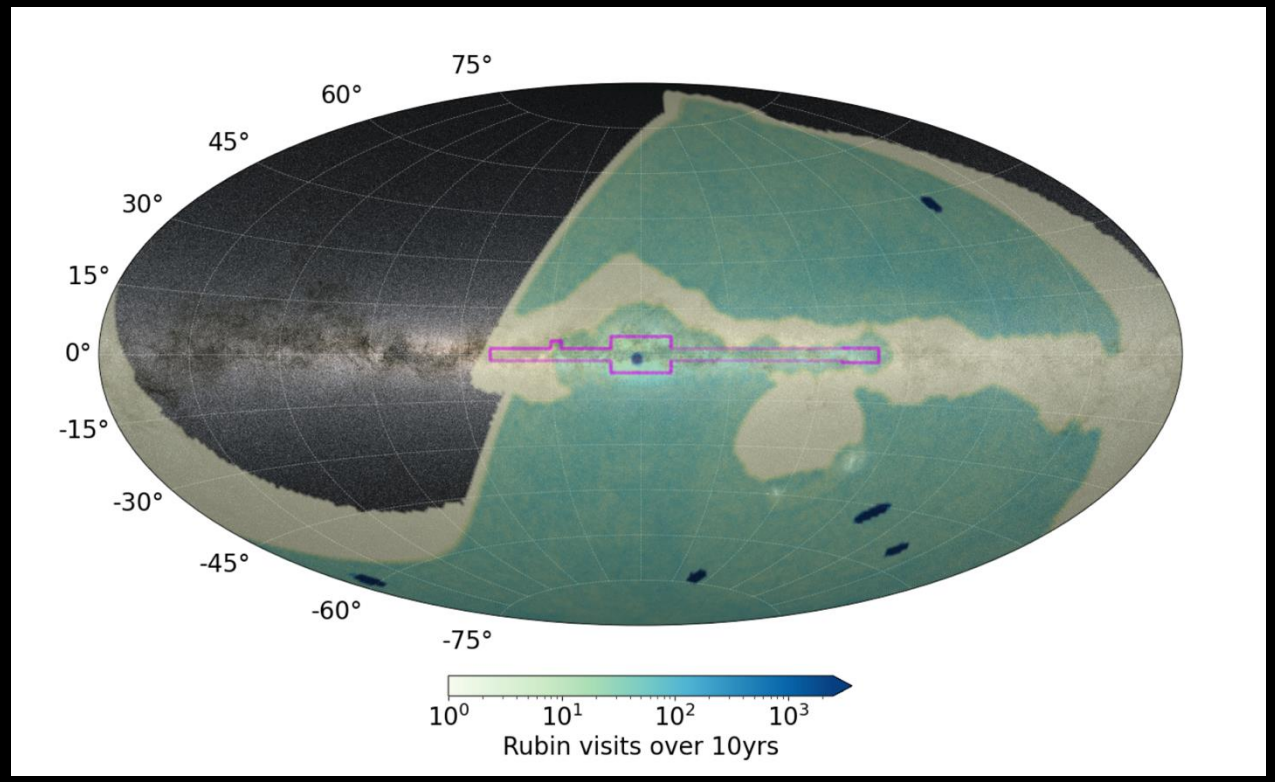
Table 4.1 Overview of the elements of the Roman Galactic Plane Survey

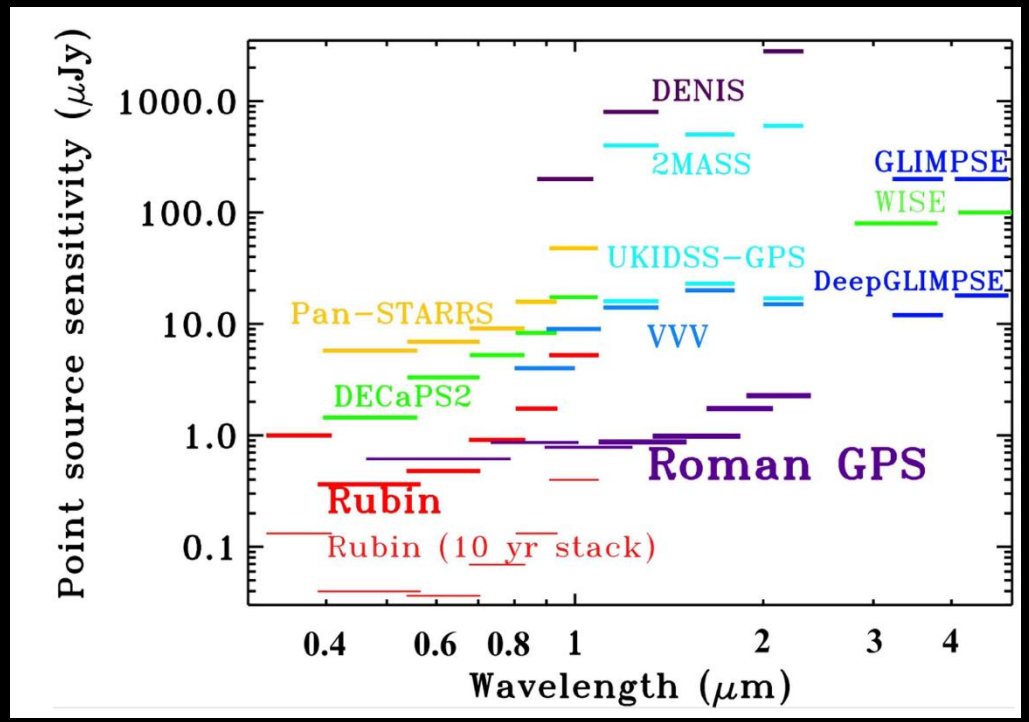
	Hours	Percent	Area(deg^2)	l_{min}	l_{max}	b_{min}	b_{max}	l_{cen}	b_{cen}	Filters/Cadence*
Wide-Field Science	**540.65**	**77.2%**	**691.15**							
Disk	382.18	54.6%	468.40	-67.00	50.10	-2.00	2.00	—	—	**F129**,F158,F184,**F213**
Disk_Carina	44.43	6.3%	54.00	-79.00	-67.00	-2.50	2.00	—	—	**F129**,F158,F184,**F213**
Bulge_Bpos	52.27	7.5%	80.00	-10.00	10.00	2.00	6.00	—	—	**F129**,F158,**F213**
Bulge_Bneg	51.94	7.4%	80.00	-10.00	10.00	-6.00	-2.00	—	—	**F129**,F158,**F213**
Serpens_South	9.83	1.4%	8.75	26.50	30.00	2.00	4.50	—	—	F106,**F129**,F158,F184,**F213**
Time-Domain Science	**129.52**	**18.5%**	**19.06**							
TDS_Carina	11.89	1.7%	2.06	-73.77	-71.19	-1.05	-0.25	—	—	F213 (min)+F062.F087,F106,F129
TDS_NGC6334_6357	11.89	1.7%	2.06	-9.15	-6.57	0.35	1.15	—	—	F213 (min)+F062,F087,F106,F129
TDS_Galactic_Center_Q4	39.04	5.6%	2.06	-2.80	-0.22	-0.53	0.28	—	—	F213 (min/hrs/wks)+F129 (wks) + F062,F087,F106,F129
TDS_Galactic_Center_Q1	39.04	5.6%	2.06	0.06	2.64	-0.53	0.28	—	—	F213 (min/hrs/wks)+F129 (wks) + F062,F087,F106,F129
TDS_Serpens_South_W40	14.86	2.1%	8.75	26.50	30.00	2.00	4.50	—	—	F213 (hrs) (+F106,F129,F158,F184,F213 from Wide Field Science)
TDS_W43	12.80	1.8%	2.06	29.31	31.89	-0.49	0.31	—	—	F184 (min)+ F062,F087,F106,F129,F213
Deep/Spectroscopic Science¶	**30.80**	**4.4%**	**4.80**							
Deep_NGC_3324_Carina	1.79	0.3%	0.32	—	—	—	—	-73.80	-0.20	All filters deep, grism,prism
Deep_Acrux	1.79	0.3%	0.32	—	—	—	—	-59.75	-0.29	All filters deep, grism,prism
Deep_NGC_5269_5281	1.79	0.3%	0.32	—	—	—	—	-50.86	-0.55	All filters deep, grism,prism
Deep_Window_319.5-0.2	1.79	0.3%	0.32	—	—	—	—	-40.50	-0.21	All filters deep, grism,prism
Deep_G333	1.79	0.3%	0.32	—	—	—	—	-27.00	-0.48	All filters deep, grism,prism
Deep_ASCC_85	1.79	0.3%	0.32	—	—	—	—	-20.17	-0.32	All filters deep, grism,prism
Deep_Teutsch_84	1.79	0.3%	0.32	—	—	—	—	-15.56	-0.46	All filters deep, grism,prism
Deep_NGC_6357_Lobster	1.79	0.3%	0.32	—	—	—	—	-6.86	0.85	All filters deep, grism,prism
Deep_Window_355.0-0.3	1.79	0.3%	0.32	—	—	—	—	-5.21	-0.37	All filters deep, grism,prism
Deep_VVV-CL001_UKS_1	1.79	0.3%	0.32	—	—	—	—	5.20	0.77	All filters deep, grism,prism
Deep_M17_Omega	1.79	0.3%	0.32	—	—	—	—	15.04	-0.73	All filters deep, grism,prism
Deep_Trumpler_35	1.79	0.3%	0.32	—	—	—	—	28.21	-0.06	All filters deep, grism,prism
Deep_W40	5.74	0.8%	0.32	—	—	—	—	28.83	3.54	Very Deep F129,F158,F213, prism
Deep_W44	1.79	0.3%	0.32	—	—	—	—	34.70	-0.40	All filters deep, grism,prism
Deep_W51	1.79	0.3%	0.32	—	—	—	—	49.40	-0.20	All filters deep, grism,prism
TOTAL	**700.97**	**100.1%**								

* "All Filters" excludes the wide F146 filter, grism, and prism. *Wide-Field Science*: Filters in bold recommended for first epoch observations.
Time Domain Science: Fields covered with all filters to "standard" observing time and single filter for repeat visits.
Note that all Time Domain fields will have F129 and F213 observations separated by > 1 year to assess variability.
¶ Single Roman pointings with x4 standard observing time (0.75 mag deeper). If grism/prism observations are not feasible, 0.4 hrs per field will be allocated to longer integrations. Pointing centers may be adjusted depending on roll angle for scheduled observations.

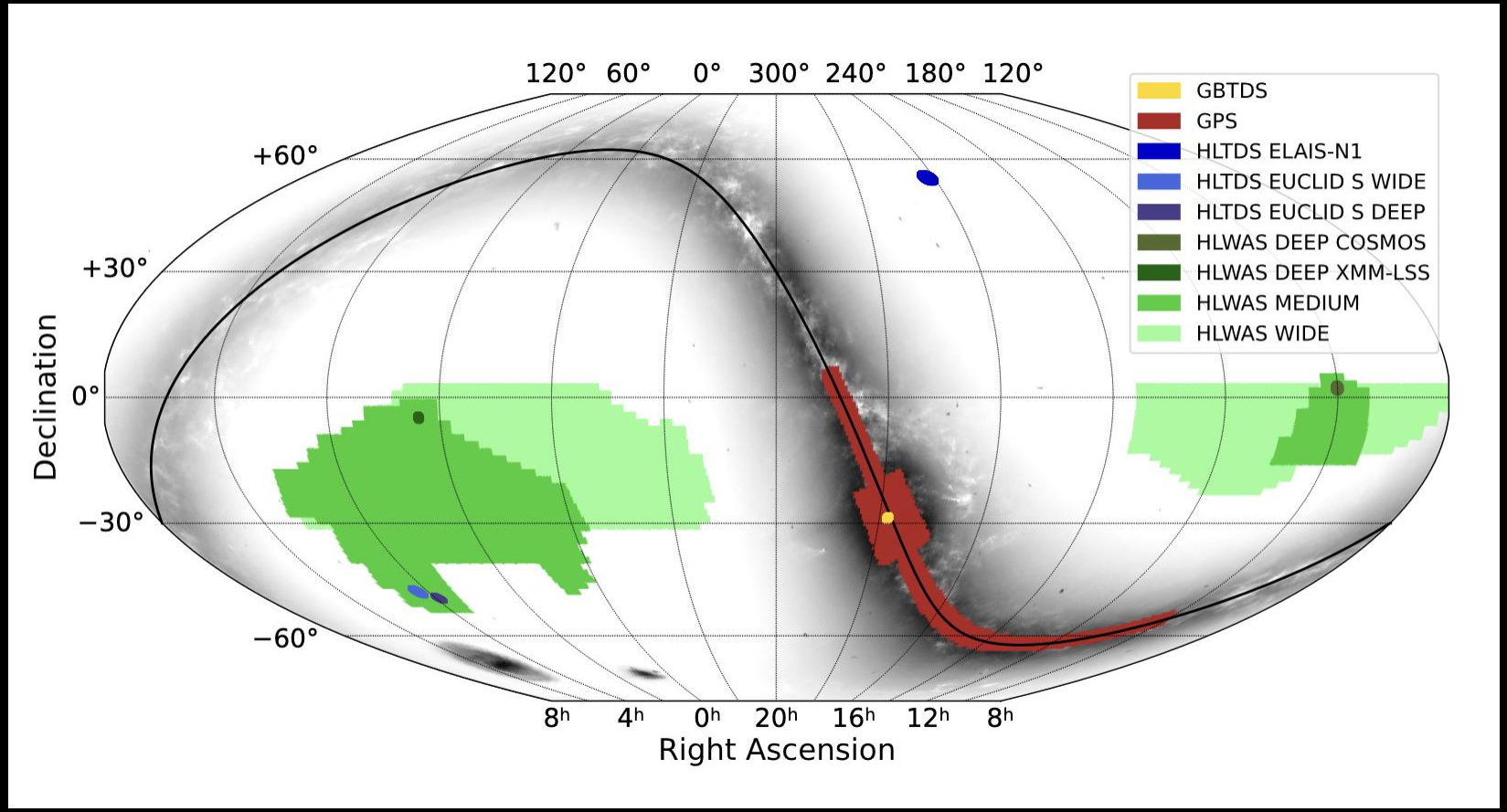
Synergies with Other Surveys

Rubin- LSST





The Roman Galactic Plane Survey and the Other Roman Observations



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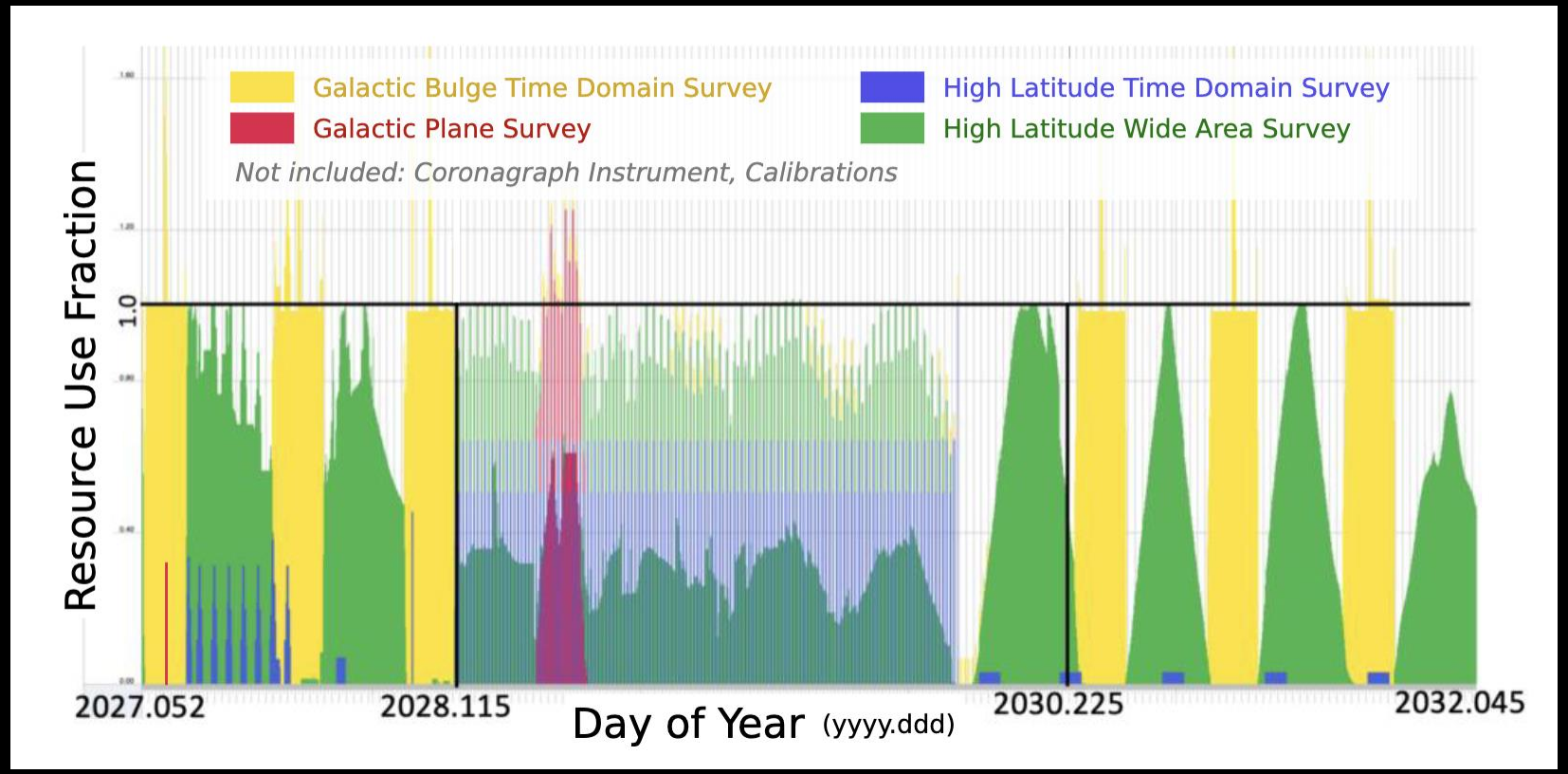

Enabled Science

I. Galactic Structure
II. Galactic Dynamics
III. Star Formation and The Interstellar Medium
IV. Low-Mass Stars, Brown Dwarfs, and Free-floating Planetary Mass Objects
V. Dust and The Extinction Curve
VI. Microlensing
VII. Star Counts
VIII. Eruptive Variables
IX. Pulsation Variables and Evolved Stars
X. Compact Binaries

Microlensing

- Microlensing events are typically identified from time series photometry, but the models suffer several degeneracies and additional data are required to unambiguously determine the mass and distance of the lens:
  - The Roman Galactic Plane Survey can deliver these constrains, e.g.:
    - for thousands of previous events by detecting light from now-separated lenses
    - by identifying the source star in contemporary events, enabled by Roman's high spatial resolution

- Synergies between Roman Galactic Plane Survey observations and past and future surveys including the VVV, OGLE, LSST and more, e.g.:
  - deblending and characterizing source stars in crowded LSST image
  - high-cadence time sampling of stellar clusters would allow FFP events to be detected

- Time-domain observations in the Galactic Plane with Roman would produce better constraints on parallax and proper motion of stars in obscured or crowded regions, for which Gaia was not designed. This could lead to better prediction of future microlensing events.