Overview

1. Roman WFI field of view & constraints

2. Reference survey strategy
   - Designed as an example to show Roman meets its science requirements.
   - The survey that Roman really carries out could look very different.

3. Alternative survey concepts
Pointing Considerations:
• Roman points 54—126° from Sun
• L2 orbit → no Earth, minimal Moon constraints
Cartoon version in Ecliptic Coordinates
“Arced” layout of chips fits in a part of an annulus.

Field of View Layout affects Survey Design.

Boresight is obstructed, not available in this class of 3-mirror telescope designs.

120° tilt relative to Sun constrains tiling layout relative to Ecliptic.
High Latitude Imaging Survey

• Main driver for the reference survey was weak lensing. Basic needs are a wide area survey with:
  1. Angular resolution (+ well understood PSF) for shapes
     Constrained by 2.4 m aperture
  2. Depth (may trade with area)
  3. Near IR photometric coverage (from space)
     + need visible data from ground for photo-z’s (Rubin/LSST or HSC)
  4. Internal cross checks

   A choice [Astro2010 guidance] was to do the shapes in NIR, and optimize the pixel size for J & H bands. Of course the pixel size of 0.11 arcsec is now a hard constraint.

• Additional data:
  ❖ Deep fields used to understand noise effects in shallower survey.
  ❖ Spectroscopic data to calibrate photo-z’s.
Choice bands from Y band (Rubin coverage) to 2 µm (beyond which background would increase dramatically).

- Reference Survey did not plan to use the visible filters for the wide survey as Rubin/LSST is providing the necessary depth.
- This pre-dates the $K_s$ filter.

Shape measurement with J & H (primary) + F184.

- Y band is most challenging for shapes due to sampling & wavefront. We intend to do shapes in Y on a best-effort basis, requirements are set for J & longer $\lambda$.
- F184 is 0.7 mag shallower than H.

Depth vs. area trade depends on how you tile the sky.

Reference survey: Shapes $n_{\text{eff}} = 50$ galaxies/arcmin$^2$ (35 in H-band only)
High Latitude Spectroscopic Survey

- 7 months / 2000 deg$^2$ of HLSS in Reference Survey. 4 passes at different roll angles, (6—8) x 297 s exposure time.
- Astro2010 version of this survey had a wide/shallow tier as well – Roman could do this, but might not be the best use of resources since the wide z~1 survey science is well covered by DESI + Euclid.
- Sensitivity of 7x10$^{-17}$ erg/cm$^2$/s for a point source in the center of the band (can be a few times higher for extended sources like galaxies).
- 14M H$\alpha$ redshifts & 3.6M [O III] redshifts in the Reference Survey (3M redshifts per month)
- Eifler et al. (2020) explores depth vs. area trade and implications for cosmological constraints.

Grism: wavelength range 1.00—1.93 μm
Example Tiling
Example Tiling
Example Tiling
Example Tiling
Example Tiling + 2\textsuperscript{nd} pass

\textit{2nd pass (yellow) must be done at a different time of year if rotated by a large angle}
Possible Placement
(from an integrated tiling simulation)

Equatorial Coordinates; dashed lines show Ecliptic & Galactic Plane
Proposal for Very Wide Survey

Suggestion to cover the Rubin footprint in wide (microlensing) filter (Eifler, Simet, Krause et al. 2020)

• 18,000 deg$^2$ per 1.5 years
• Similar concept to the large survey with Euclid-VIS, but with a NIR filter
• Enormous statistical constraining power …
• but won’t by itself provide the internal checks that we need, or as good of photo-z information at $z>1$

Considerations:

• Two tier strategy?
• How much Reference vs. Wide to do in the 5-year primary mission?
Multi-tiered surveys?

This example had an H band only survey (red, 5000 deg²) with Y/J/H/F184/grism coverage in a smaller region (yellow).
K band?

K band at same exposure time
25.0 mag (5σ pt src)
~2 mag shallower for extended src shapes
$n_{\text{eff}} = 12$ gal/arcmin$^2$

- K band filter (1.95—2.30 µm) added in late 2020.
- I’ve shown where this lands with the same exposure time as the other filters. +4 months to observe 2000 deg$^2$.
- Due to thermal background, probably can’t compete with H for shapes. But might do a part of the survey to higher depth to cross-check shape measurements with a PSF that is better sampled? Or for other survey science?
Final Thoughts

• There is a reference High Latitude Survey for imaging and spectroscopy.
  • Used for setting science requirements, and presented at our reviews up through CDR.
  • Ultimately traces back to Astro 2010 science objectives.

• However, the trade space for the survey we execute remains open.
  • Area/depth, multi-tier, which filters, footprint placement …
  • Total observing time is a constraint. What to do in 5-year primary mission?