Catalog-level Simulations of a High Latitude Time Domain Survey for the Nancy Grace Roman Space Telescope

Phillip Macias (UC Santa Cruz)
+ Foley SIT

pmacias@ucsc.edu
**Goal (for talk)**

- Describe how catalog-level simulations are generated, how they are being used to prepare for Roman, and describe ongoing/future work

**Motivation (post Hounsell et al. 2018)**

- updates to hardware and Roman capabilities are non-trivial to propagate to cosmology results (e.g. slew/settle time, filter throughputs)

- ongoing work to quantify systematic effects on cosmological inferences

- decisions remain to be made for major survey choices (e.g. fraction of time dedicated to spectroscopy)

- preparatory work for synergy with existing and future facilities

- variations / optimization
SIMULATIONS OF THE WFIRST SUPERNova SURVEY AND FORECASTS OF COSMOLOGICAL CONSTRAINTS


Figure 12. Predicted dark energy FoMs for the simulated WFIRST SN survey strategies outlined in Section 5. IFC-focused and WFC-focused strategies are presented in the top and bottom panels, respectively. The gradients for each strategy represent the range of FoMs from FoM_{tot,curr} (dotted lines) to FoM_{tot,opt}. The thick black lines represent FoM_{stat}. The red dashed vertical line indicates the current FoM value of 32.6 (Alam et al. 2016).
The Supernova Analysis Package (SNANA)

https://github.com/RickKessler/SNANA

Image: R. Kessler
Pippin Pipeline for Supernova Survey Analysis

https://github.com/Samreay/Pippin

survey level choices: cadence, depth, filters, tiers, fields

Task finished with wall time 0:07:23
FINISHED: AnalyseChains BANANA_OMW task (wall time 0:07:23, 1 jobs, deps ['SN_BANANA_OMW_NGRST_COV_BBC']) with 1 NUM_JOBS. NUM_JOBS now 0

CURRENT TASK STATUS
Key: WAITING RUNNING DONE FAILED BLOCKED
SIM NGRST_BIASCOR_G10 FOUND_BIASCOR_G10 NGRST_SIMDATA_G10 FOUND_SI
LCFIT NGRSTfit_SIM_NGRST_SIMDATA_G10 NGRSTfit_BIAS_NGRST_BIASCOR_G10 F
FOUNDfit_BIAS_FOUND_BIASCOR_G10
CLASSIFY FITPROBTEST FITPROBTEST
AGGREGATE AGG_NGRST_BIASCOR_G10 AGG_FOUND_BIASCOR_G10 AGG_NGRST_SIMDATA_G1
MERGE MERGE_NGRSTfit_SIM_NGRST_SIMDATA_G10 MERGE_NGRSTfit_BIAS_NGRST_BIA
MERGE_FOUNDfit_SIM_FOUND_SIMDATA_G10 MERGE_FOUNDfit_BIAS_FOUND_SI
BIASCOR BBC
CREATE_COV NGRST_COV_BBC
COSMOMC SN_BANANA_OMW_NGRST_COV_BBC
ANALYSE BANANA_OMW

All tasks finished. Task summary as follows.
Successfully completed tasks:
  SNANASimulation NGRST_BIASCOR_G10 task (wall time 1:28:17, 1 jobs, deps
  SNANASimulation FOUND_BIASCOR_G10 task (wall time 0:54:49, 1 jobs, deps
  SNANASimulation NGRST_SIMDATA_G10 task (wall time 1:05:03, 1 jobs, deps
  SNANASimulation FOUND_SIMDATA_G10 task (wall time 1:02:04, 1 jobs, deps...
  SNANALightCurveFit NGRSTfit_SIM_NGRST_SIMDATA_G10 task (wall time 2:46:40, 12 jobs, deps ['NGRST_SIMDATA_G10'])
  SNANALightCurveFit NGRSTfit_BIAS_NGRST_BIASCOR_G10 task (wall time 11:34:02, 36 jobs, deps ['NGRST_BIASCOR_G10'])
  SNANALightCurveFit FOUNDfit_SIM_FOUND_SIMDATA_G10 task (wall time 0:29:37, 10 jobs, deps ['FOUND_SIMDATA_G10'])
  SNANALightCurveFit FOUNDfit_BIAS_FOUND_BIASCOR_G10 task (wall time 0:44:56, 10 jobs, deps ['FOUND_BIASCOR_G10'])
  FitProbClassifier FITPROBTEST task (wall time 0:00:00, 1 jobs, deps ['NGRST_SIMDATA_G10', 'NGRSTfit_SIM_NGRST_SIMDATA_G10'])
  FitProbClassifier FITPROBTEST task (wall time 0:00:23, 1 jobs, deps ['FITPROBTEST'])
  Aggregator AGG_NGRST_BIASCOR_G10 task (wall time 0:00:23, 1 jobs, deps ['FITPROBTEST'])
  Aggregator AGG_FOUND_BIASCOR_G10 task (wall time 0:00:13, 1 jobs, deps ['FOUND_BIASCOR_G10'])
  Aggregator AGG_NGRST_SIMDATA_G10 task (wall time 0:00:18, 1 jobs, deps ['FITPROBTEST'])
  Aggregator AGG_FOUND_SIMDATA_G10 task (wall time 0:00:08, 1 jobs, deps ['FOUND_SIMDATA_G10'])

...
Pippin Pipeline for Supernova Survey Analysis

https://github.com/Samreay/Pippin

survey level choices: cadence, depth, filters, tiers, fields

Task finished with wall time 0:07:23
FINISHED: AnalyseChains BANANA_OMW task (wall time 0:07:23, 1 jobs, deps ['SN_BANANA_OMW_NGRST_COV_BBC']) with 1 NUM_JOBS. NUM_JOBS now 0

CURRENT TASK STATUS
Key: WAITING RUNNING DONE FAILED BLOCKED
SIM
NGRST_BIASCOR_G10 FOUND_BIASCOR_G10 NGRST_SIMDATA_G10 FOUND_SIMDATA_G10
LCFIT
NGRSTfit_SIM_NGRST_SIMDATA_G10 NGRSTfit_BIAS_NGRST_BIASCOR_G10 FOUNDfit_SIM_FOUND_SIMDATA_G10
CLASSIFY
FITPROBTEST FITPROBTEST
AGGREGATE
AGG_NGRST_BIASCOR_G10 AGG_FOUND_BIASCOR_G10 AGG_NGRST_SIMDATA_G10 AGG_FOUND_SIMDATA_G10
MERGE
MERGE_NGRSTfit_SIM_NGRST_SIMDATA_G10 MERGE_NGRSTfit_BIAS_NGRST_BIASCOR_G10
BIASCOR
BCC
CREATE_COV
NGRST_COV_BCC
COSMOC
SN_BANANA_OMW_NGRST_COV_BCC
ANALYSE
BANANA_OMW

All tasks finished. Task summary as follows.
Successfully completed tasks:
  SNANASimulation NGRST_BIASCOR_G10 task (wall time 1:28:17, 1 jobs, debs)
  SNANASimulation FOUND_BIASCOR_G10 task (wall time 0:54:49, 1 jobs, debs)
  SNANASimulation NGRST_SIMDATA_G10 task (wall time 1:05:03, 1 jobs, debs)
  SNANASimulation FOUND_SIMDATA_G10 task (wall time 1:02:04, 1 jobs, debs)
  SNANALightCurveFit NGRSTfit_SIM_NGRST_SIMDATA_G10 task (wall time 2:24:41, 1 jobs, debs)
  SNANALightCurveFit NGRSTfit_BIAS_NGRST_BIASCOR_G10 task (wall time 11:06:17, 1 jobs, debs)
  SNANALightCurveFit FOUNDfit_SIM_FOUND_SIMDATA_G10 task (wall time 0:25:36, 1 jobs, debs)
  SNANALightCurveFit FOUNDfit_BIAS_FOUND_BIASCOR_G10 task (wall time 0:23:01, 1 jobs, debs)
  FitProbClassifier FITPROBTEST task (wall time 0:00:00, 1 jobs, debs)
  FitProbClassifier FITPROBTEST task (wall time 0:00:00, 1 jobs, debs)
  Aggregator AGG_NGRST_BIASCOR_G10 task (wall time 0:00:23, 1 jobs, debs)
  Aggregator AGG_FOUND_BIASCOR_G10 task (wall time 0:00:13, 1 jobs, debs)
  Aggregator AGG_NGRST_SIMDATA_G10 task (wall time 0:00:18, 1 jobs, debs)
  Aggregator AGG_FOUND_SIMDATA_G10 task (wall time 0:00:08, 1 jobs, debs ['FOUND_SIMDATA_G10'])

2: fit light-curves

Wide z=0.47

Roman Science Team Community Briefing 11/18
Pippin Pipeline for Supernova Survey Analysis

https://github.com/Samreay/Pippin

survey level choices: cadence, depth, filters, tiers, fields

3: transient classification (Helen's talk!)
Pippin Pipeline for Supernova Survey Analysis

https://github.com/Samreay/Pippin

survey level choices: cadence, depth, filters, tiers, fields

6: calculate distances, produce HD

All tasks finished. Task summary as follows.
Successfully completed tasks:

- SNANASimulation NGRST_BIASCOR_G10 task (wall time 1:28:17, 1 jobs, deps [])
- SNANASimulation FOUND_BIASCOR_G10 task (wall time 0:54:49, 1 jobs, deps [])
- SNANASimulation NGRST_SIMDATA_G10 task (wall time 1:05:03, 1 jobs, deps [])
- SNANASimulation FOUND_SIMDATA_G10 task (wall time 1:02:04, 1 jobs, deps [])
- SNANALightCurveFit NGRSTfit_SIM_NGRST_SIMDATA_G10 task (wall time 2:46:40, 1 jobs, deps [])
- SNANALightCurveFit FOUNDfit_SIM_FOUND_SIMDATA_G10 task (wall time 0:29:37, 1 jobs, deps [])
- SNANALightCurveFit FOUNDfit_BIAS_FOUND_BIASCOR_G10 task (wall time 0:44:56, 1 jobs, deps [])
- FitProbClassifier FITPROBTEST task (wall time 0:00:00, 1 jobs, deps ['NGRST_BIASCOR_G10', 'NGRST_SIMDATA_G10'])
- Aggregator AGG_BIASCOR_G10 task (wall time 0:00:23, 1 jobs, deps ['FITPROBTEST'])
- Aggregator AGG_FOUND_BIASCOR_G10 task (wall time 0:00:13, 1 jobs, deps ['FOUND_BIASCOR_G10'])
- Aggregator AGG_FOUND_SIMDATA_G10 task (wall time 0:00:18, 1 jobs, deps ['FITPROBTEST'])
- Aggregator AGG FOUND_SIMDATA_G10 task (wall time 0:00:08, 1 jobs, deps ['FOUND_SIMDATA_G10'])

BBC paper

\[ w_0 = -1.05 \]
Pippin Pipeline for Supernova Survey Analysis

https://github.com/Samreay/Pippin

survey level choices: cadence, depth, filters, tiers, fields

8+9: explore cosmological-parameter space, calculate likelihoods

+ ...
### Reference Survey

<table>
<thead>
<tr>
<th>Mode</th>
<th>Tier</th>
<th>(z_{\text{targ}})*</th>
<th>Filters</th>
<th>Exp.Time+Overhead (s)</th>
<th>No. of Pointings</th>
<th>Area (deg(^2))</th>
<th>Time/Visit (hours)</th>
<th>Total SN Ia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imaging</td>
<td>Wide</td>
<td>1.0</td>
<td>RZYJ, 160;100;100;100 + 70x4</td>
<td>68</td>
<td>19.04</td>
<td>14.0</td>
<td>8804</td>
<td></td>
</tr>
<tr>
<td>Imaging</td>
<td>Deep</td>
<td>1.7</td>
<td>YJHF, 300;300;300;900 + 70x4</td>
<td>15</td>
<td>4.20</td>
<td>8.5</td>
<td>3520</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>22.5</strong></td>
<td><strong>12324</strong></td>
</tr>
<tr>
<td>Spec</td>
<td>Wide</td>
<td>1.0</td>
<td>prism</td>
<td>900 + 70</td>
<td>12</td>
<td>3.36</td>
<td>3.2</td>
<td>831</td>
</tr>
<tr>
<td>Spec</td>
<td>Deep</td>
<td>1.5</td>
<td>prism</td>
<td>3600 + 70</td>
<td>4</td>
<td>1.12</td>
<td>4.1</td>
<td>652</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>7.3</strong></td>
<td><strong>1483</strong></td>
</tr>
</tbody>
</table>

\(z_{\text{targ}}\) denotes the redshift where the average SN Ia at peak is observed with S/N=10 per exposure.

**Table 1.** The 25% reference survey strategy

FoM requirements met

---

![Graph showing distribution of \(N_{\text{tot}} = 12,471\) with redshift \(z\).]

**Figure 1.** Distribution of \(N_{\text{tot}} = 12,471\) with redshift \(z\).
Redshift Acquisition

based on existing and future (Roman HLS, Euclid) galaxy catalogs, we can estimate fraction of host-galaxies that will have a redshift attainable without HLTDS spectra

~1,300 SN Ia host redshifts from Subaru+PFS

~7,500 SN Ia host-z from Roman Grism

Ground-based specz for See Change low-SFR hosts (Williams+ 2020)

from a total of ~11,800 SN Ia detections (net efficiency ~74%)
Low-z Sample

- low-z sample is necessary to “anchor” Hubble Diagram

- at ~5k SNe this sample saturates in its cosmological utility (systematics limited)

pmacias@ucsc.edu

Macias et al., in-prep

+ lots more work in progress!