S5 Error Budget Presentation to SIP

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Overview

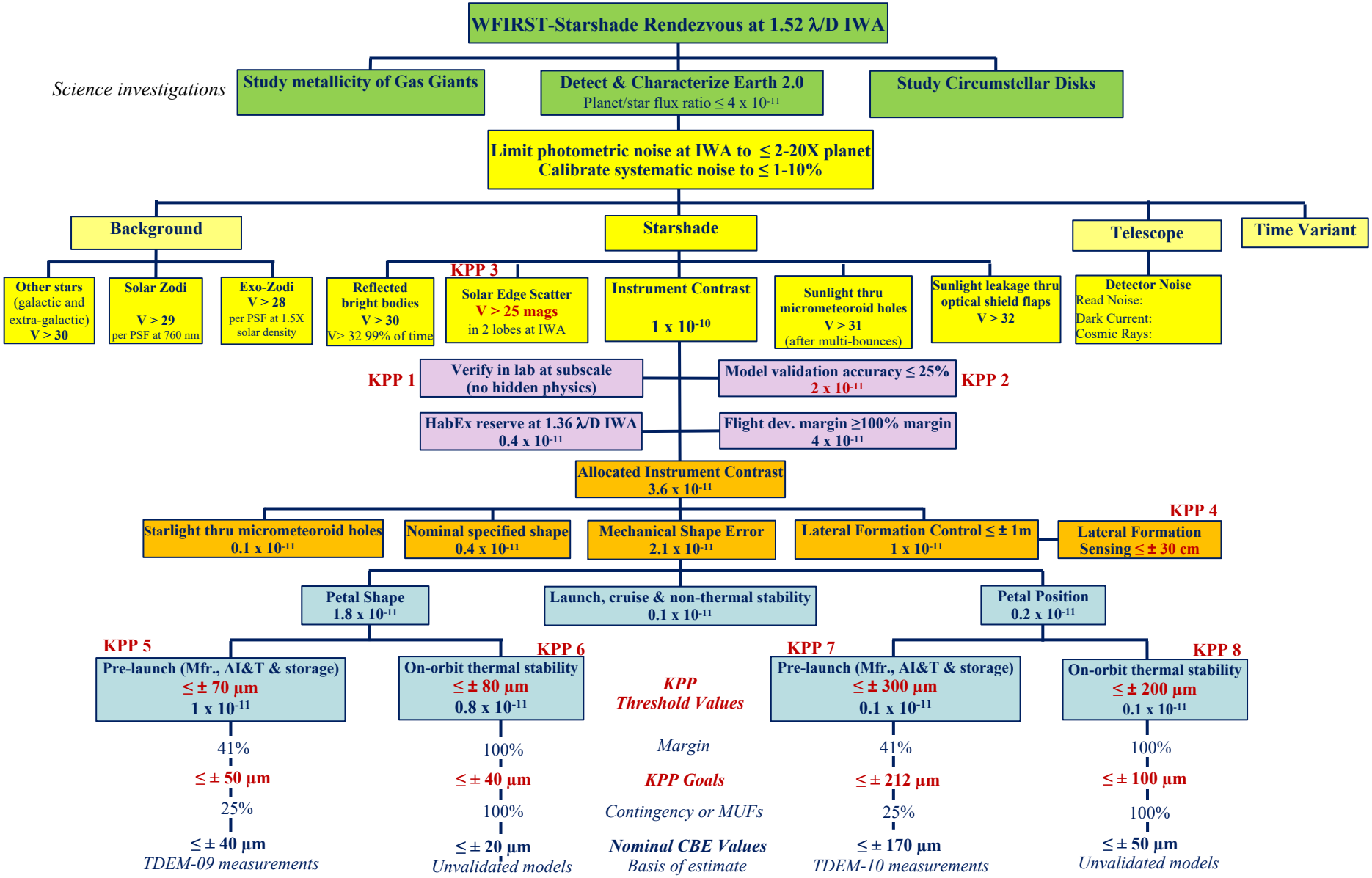
- **A top level S5 error budget is presented herein that identifies all 8 of the Key Performance Paramters (KPPs) whose verification is the S5 focus**
  - Rolls up from a detailed error budget maintained by Stuart Shaklan (Shaklan et al, 2017 SPIE Vol 104001)
- **Instrument contrast drives 7 of the 8 S5 KPPs and is conservatively allocated at 1E-10 to not drive integration times**
  - Instrument contrast is defined as the energy ratio of the residual starlight at any point in the telescope focal plane relative to the starlight at the same point without the starshade
- **The S5 Error Budget is referenced to the WFIRST Rendezvous Mission but also carries reserve instrument contrast to address the HabEx Mission**
  - HabEx is slightly more sensitive to shape errors due to operating at 1.36 λ/D IWA vs. 1.5 λ/D
- **The S5 Error Budget carries large margins and a status is given**
- **A top-down Monte Carlo analysis is also discussed**

Mechanical Shape Error Roll-Up

Errors	Pre-Launch			Launch & Cruise			On-orbit		
	Manufacture	AI&T	Storage	Launch	Pre-deploy	Deployment	Materials	Dynamics	Thermal
In-plane	**KPP5** Petal Shape Errors $\leq \pm 70$ µm 1×10^{-11}			Other Errors 0.1×10^{-11}					**KPP6** Petal Shape Errors $\leq \pm 80$ µm 0.8×10^{-11}
In-plane	**KPP7** Petal Position Errors $\leq \pm 300$ µm 0.1×10^{-11}								**KPP8** Petal Position Errors $\leq \pm 200$ µm 0.1×10^{-11}
Out-plane									

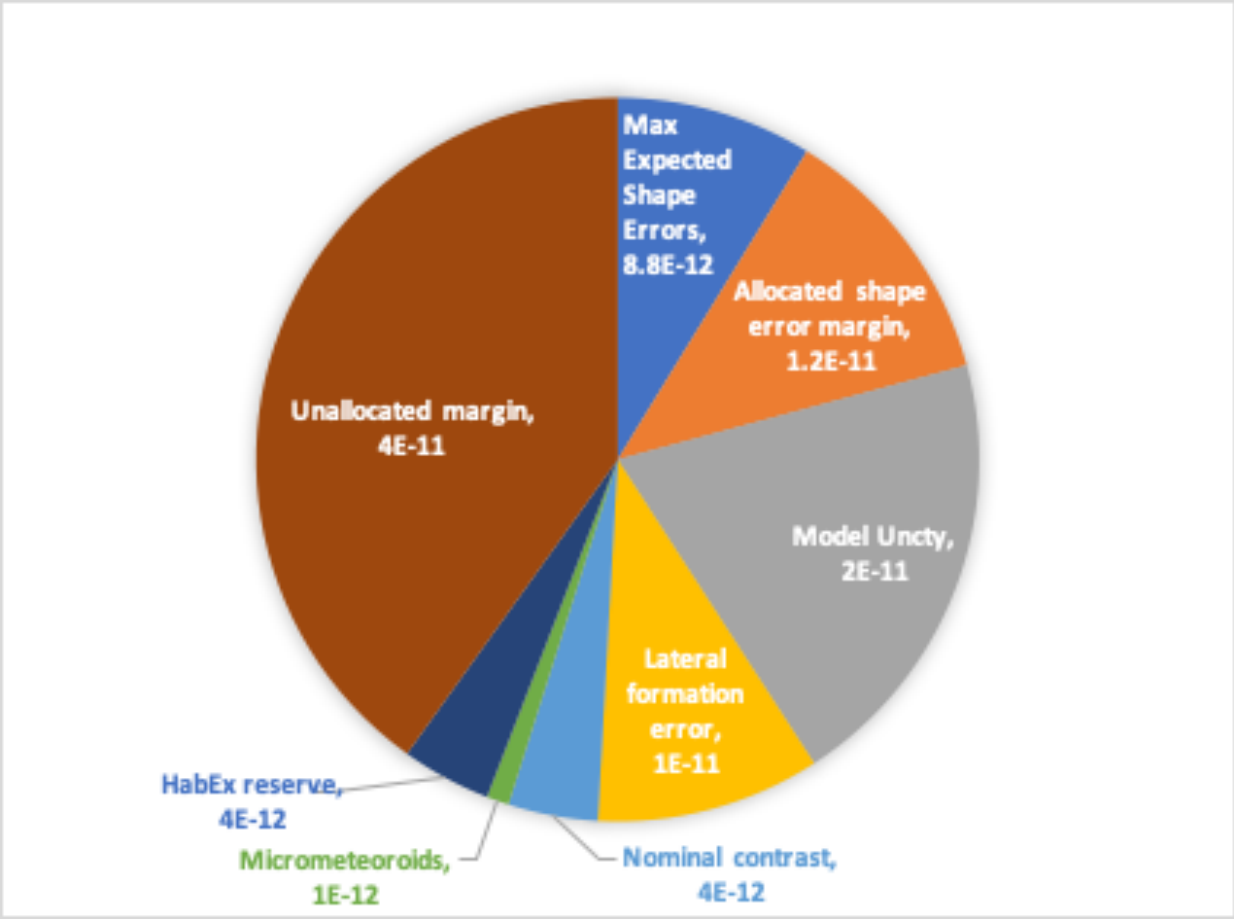
S5 Top Level Error Budget

Exoplanet Exploration Program



S5 Error Budget Margins

- Mechanical shape errors (KPP 5-8) are allocated large margins (allocated & unallocated)
- One motivation to carry large margins was to cover uncertain performance of low-cost, readily available shape metrology systems (both room temp and over temperature systems)
- But, our low-cost metrology is performing beyond expectation
- We currently expect to not consume the margin



Top-Down Monte Carlo Simulation

- **The error budget adds the nominal field separately and does not capture the mixing term between the nominal field and perturbations**
  - $(\text{Nominal} + \text{Perturbation})^2 = \text{Nominal}^2 + \text{Perturbation}^2 + 2*\text{Nominal}*\text{Perturbation}$
- **For this reason we conducted a top-down Monte Carlo (MC) simulation that includes all mixing terms in 2018**
- **The MC simulation confirmed the mean value predicted by the error budget but shows a broader distribution**
- **The MC result shows that we have 99% confidence to meet the allocated mechanical shape error with max expected errors (CBE + contingency) and 100% margin**