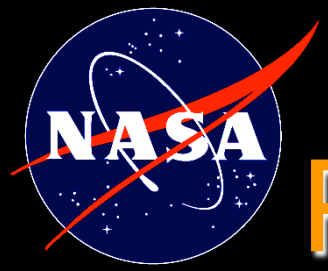

Potential new SAG(s): Capabilities of Direct Imaging Technologies and Missions

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How the press views our community

From Nature, Jan 1, 2015

ASTRONOMY

Planet hunters plot a course

Researchers aim to set aside differences in search for life on distant worlds.

BY ALEXANDRA WITZE

Scott Gaudi is tired of the fighting. An astronomer at Ohio State University in Columbus, he specializes in the notoriously fractious field of exoplanet research, in which battles have included bitter fights over data access and epic rifts between teams searching for planets outside our Solar System.

On 4 January in Seattle, Washington, Gaudi will take a tentative first step towards corralling this rowdy bunch. As chair of NASA's Exoplanet Exploration Program Analysis Group, he will try to nudge a roomful of US exoplanet scientists into generating a coherent, specific vision for where the field should go.

The time is right. Researchers have almost finished combing through the thousands of leads that were produced by NASA's planet-hunting Kepler spacecraft between 2009 and 2013, and are squeezing some more data out of the craft's limited 'K2' mission extension (see *Nature* **514,** 414–415; 2014). By the mid-2020s, budgets permitting, astronomers expect to have a satellite called the Wide-Field Infrared Survey Telescope (WFIRST) busy cataloguing planets that are too far away from their host stars for Kepler to have spotted them.

Together, Kepler and WFIRST will produce a rough census of how many planets there are in our Galaxy. But NASA has yet to work out how to tackle the next, more crucial questions: could anything actually live on any of these planets? And what will it take to understand a given world's chances of being habitable?

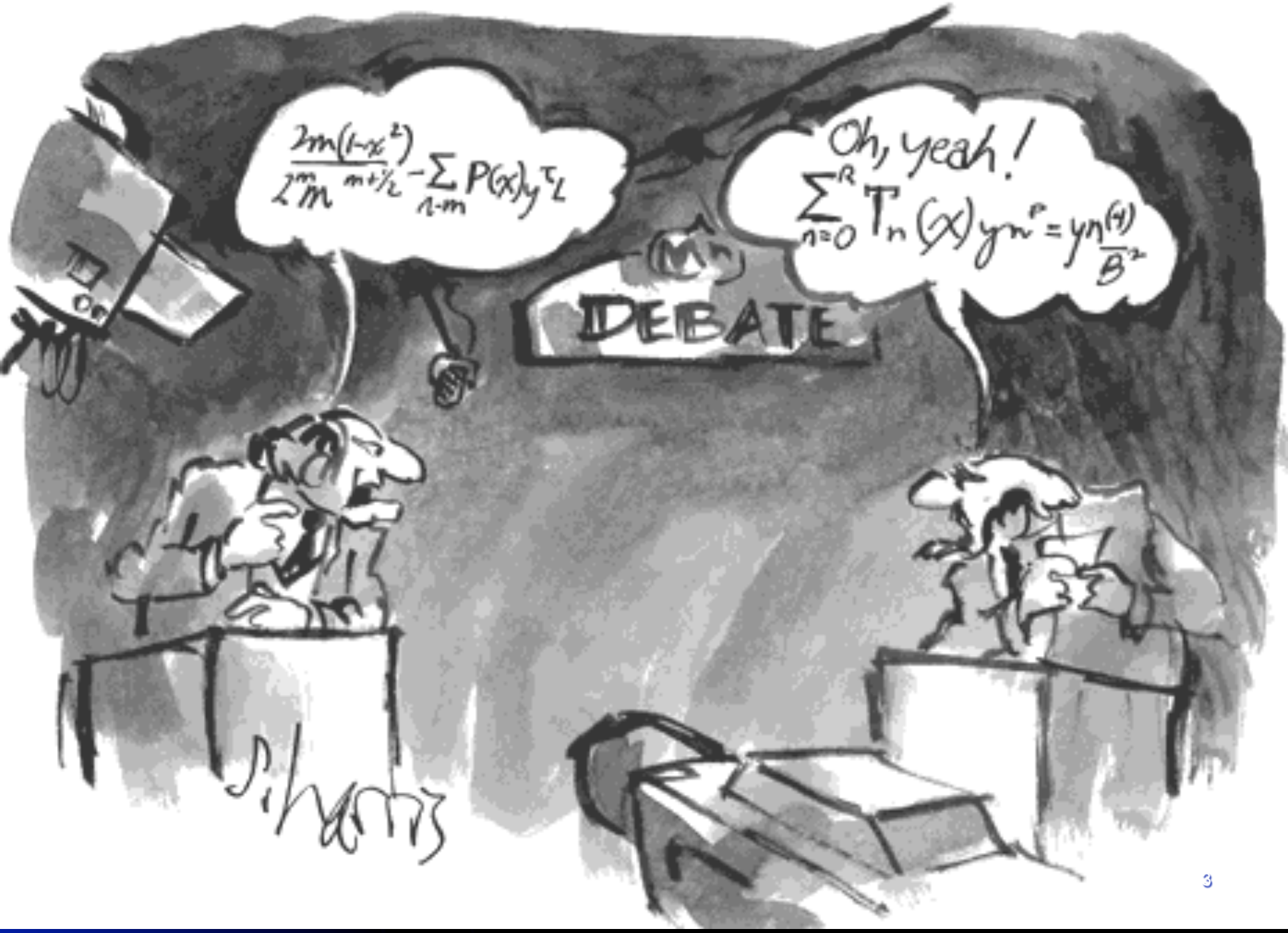
"The big thing we're wondering now is: what is it that we want to do after WFIRST?" says Gaudi.

He and others say that it is not too early to start worrying. NASA prioritizes its missions according to community surveys that happen every ten years. Exoplanet science fared badly in the 2010 survey, partly because the community could not agree on a unified vision.

"We live in a time where, for the first time in

THE WASHING

Nearly everyone agrees that the next big step would be a space telescope that could observe alien worlds directly. (Kepler uses


$\frac{2m(1-x^2)}{\Gamma^m_m}\,{}^{m+1/2}_{1-m}-\sum P(x)y^{\tau}_{L}$
DEBATE
Oh, yeah!
$\sum_{n=0}^{R} T_n(x)y_n = y_n\frac{(4)}{B^2}$

Sampling of Direct Imaging Mission Concepts

aCEND/ ACESAT (Belikov, Bendek et al.) 0.25-0.45m

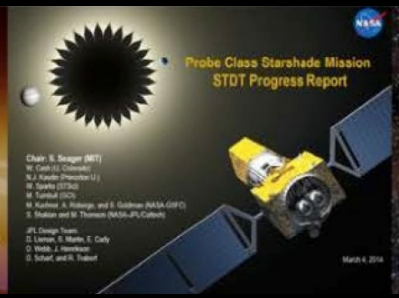
EXCEDE Schneider et al. 0.7m

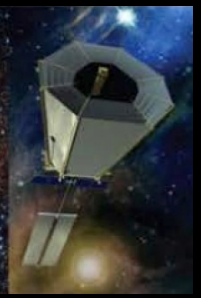
Exo-C Stapelfeldt et al. 1.4m

Exo-S Seager et al. 1.1m

AFTA-C/S 2.4m

NWT/ ATLAST 4m+





SMEX / mid-EX
Early 2020 decade

$1B probes
Mid-2020 decade

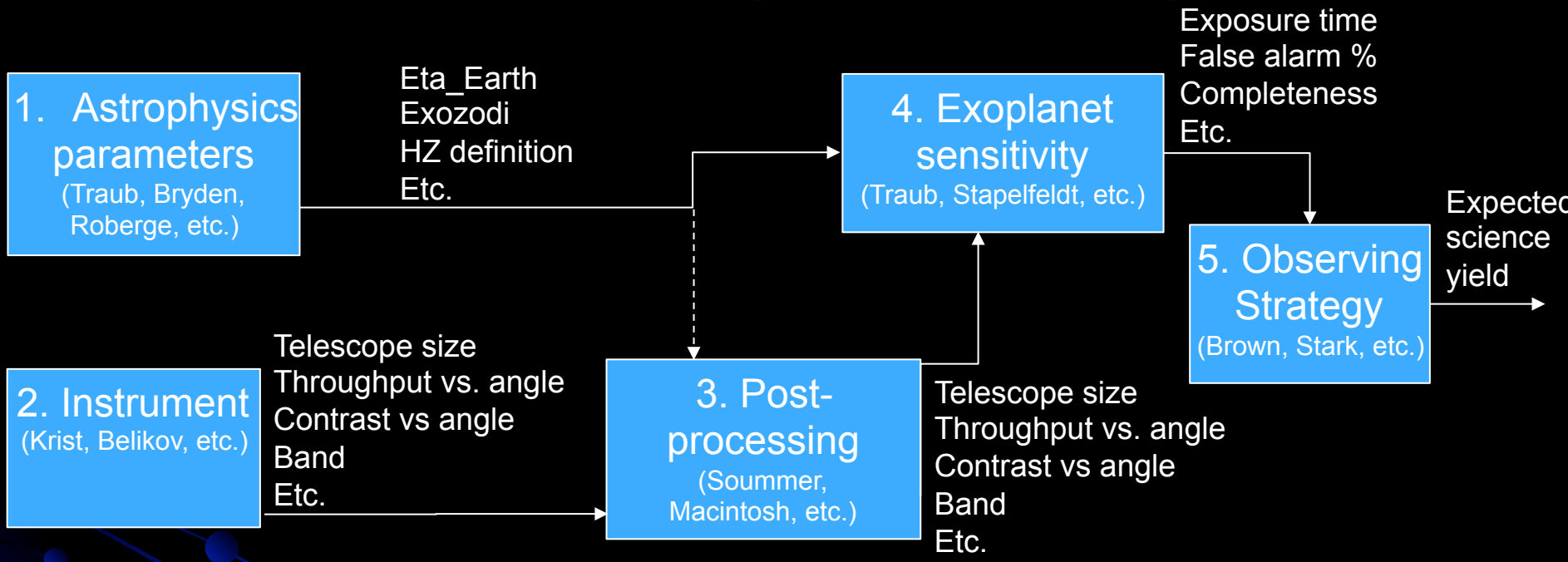
2020s flagship

2030s flagship

Main Goal: help unify our community

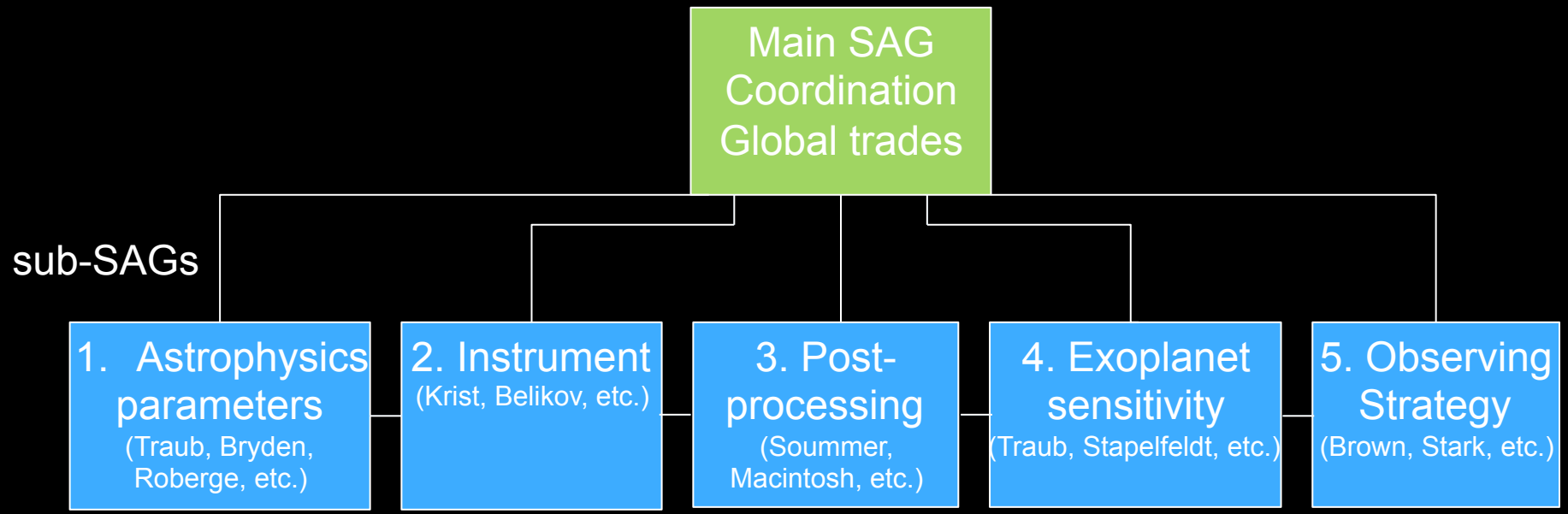
- "Unification" = we all agree on which mission to fly with what technology (at least at a flagship level for Astro 2020)
- Fundamental prerequisite: Standardization of mission yield analysis. This hopefully allows
  - A way of comparing direct imaging missions / technologies that hopefully everyone can agree on
  - Expected science yields based on a process endorsed by the entire community
  - Trade studies and understanding of how science depends on instrument parameters
  - Traceable flow-down between science and instrument requirements
  - = credible mission strategy and perception of unity for Astro 2020
- How do we accomplish this?
  - Break up the analysis into ~ 5 approximately stand-alone modules
  - Define interfaces between each module within a unified framework
  - Assign a 1-year SAG/subSAG to each module (~5 SAG-year effort)

Example unified framework for science yield analysis



- Proposed strategy:
- 1. Converge on a final version of this diagram – please contact me if you would like to volunteer
- 2. Interested parties form SAGs focused on each box, with a lead assigned to each
  - Work internally to define standard computation methods, reconcile any differences
  - Work with adjacent SAG to define interfaces
- 3. Use the resulting structure to
  - Compute expected planet yields for different missions and for a set of standard astrophysics cases
  - Conduct trade studies (e.g. science vs. telescope size or IWA)
  - Invert the computation to derive required instrument specs from desired planet yields (from SAG4 and 9)

Org structure



- Prospective SAG members: please contact me (ruslan.belikov@nasa.gov) and state whether you are interested in
  - participating in a specific box
  - leading a specific box
- Please also send me work you've done related to any of the boxes (if you have not already)

Sampe template for science yield table

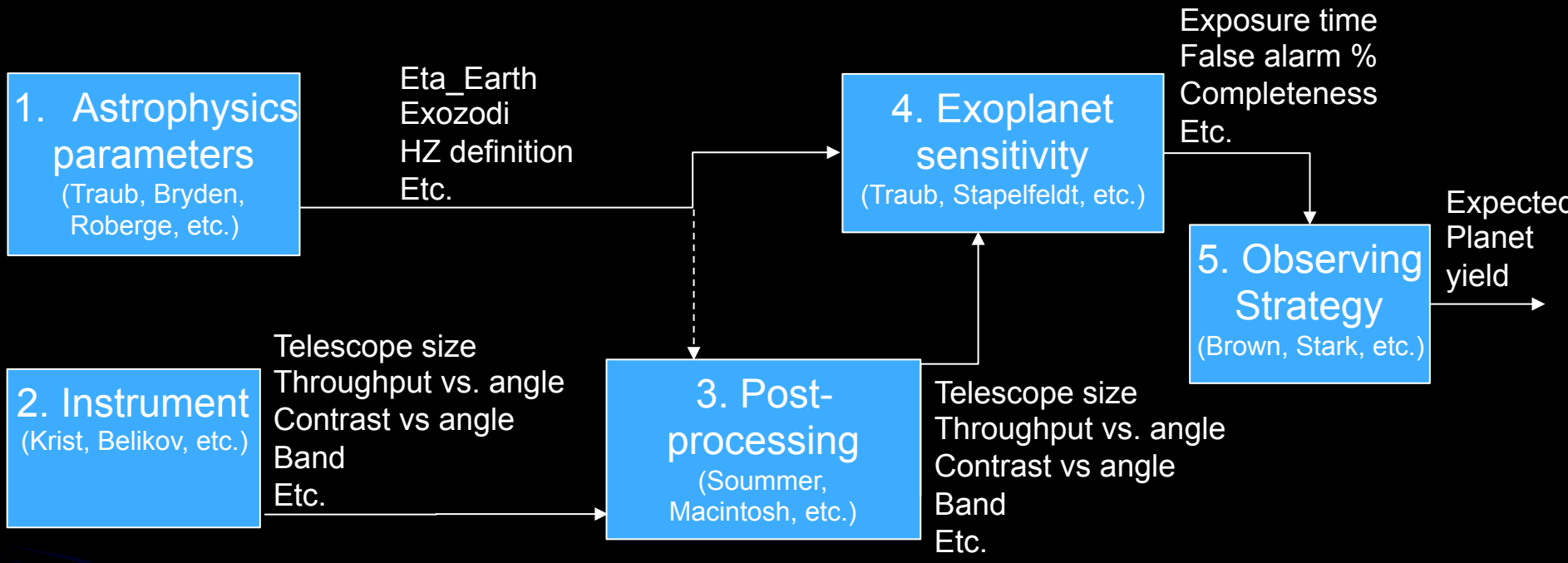
Science yield parameter	Exo-S	Exo-C	AFTA-C	Etc.
Number of known RV Jupiter-mass planets spectroscopically characterized				
Number of stars searched for HZ planets down to Earth sizes Number of planets expected				
Number of stars searched for 2 Re sub Neptunes Number of planets expected				
Number of stars surveyed for Jupiters Number of planets expected				
Number of known circumstellar disk targets surveyed				

Alternative template

	Exo-C	Exo-S	Etc.
Prescribed (assumptions, design parameter)			
Star List			
eta_planet exozodi			
assumption N			
Derived:			
Derived: parameter 1			
Derived: Parameter 2			
Risks			
If <this input assumption is instead X>	Then consequence	Then consequence	
Opportunities			
If <this input assumption is instead X>	Then consequence	Then consequence	

(based on a suggestion from Gary Blackwood)

Possible downscopes to 1 SAG



- If the ~5 SAG effort is not possible, two proposed downscopes to 1 SAG are:
  - Focus on Instrument (Box #2):
    - Compute/compare instrument performance for different missions / technologies / environment assumptions
    - study trade-offs between IWA, Contrast, sensitivity to aberrations
  - Focus on gathering Exoplanet yield calculations:
    - Gather/compare inputs from the community about planet yields for different missions without attempting to standardize computations

Request for feedback and volunteers

- Looking for constructive negative feedback on general approach

- Prospective SAG members: please contact me (ruslan.belikov@nasa.gov) and state whether you are interested in
  - participating in a specific box
  - leading a specific box
  - contribute information / input to a specific box (work you or somebody else has done)