SIG 1 Virtual Meeting, June 2nd, 2015
Amy Lo's Notes

Caveat: I summarized comments rather than type verbatim, hopefully got the gist right. My apologies for any inaccuracies. The chat transcripts are shown in italics and should be verbatim. Thanks to Chuck Lillie for additional notes.

Presentation by Scott: notes only contain info not in explicitly Scott's charts

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Background on Pauls' charge and today's meetings

- Goal of Sig #1
- Successful outcome
- Start with the Science and a broad, coherent plan, then drill down to the how's
- White paper from Paul
- Main goal of meeting is solicit input for response to Paul
- Go to ExoPAG web page, first link is to inputs
    - including Pauls' letter, roadmap, reference documents
    - also see the COPAG website, especially a large set of white papers
- respond to all of the missions, keep the set small as possible
- meetings have been going on to discuss the response
- PAGs met and decided to have at least a joint executive summary to outline areas of agreement and disagreement, if not more
- Inputs to Scott condensed to bullet points, will be available on ExoPAG website
- General point from Paul: no prioritizing missions for this response
- Go over the 4 missions
    - Far IR Surveyor
    - Hab-Exoplanet Imaging Mission
    - UV/Optical/IR surveyor
    - X-ray surveyor
    - Don't read too much into the word surveyor
- It's up to us to define what we mean by these missions

Discussion

Dashed lines separates discussion topics; italics indicate comments from on-line chat. I've tried to place them in context of the voice discussions, at least chronologically.

<u>Starshade With WFIRST</u>

Dave Bennett: why is there no mention of Starshade w/WFIRST?
Scott: It's a Probe class mission, cost from Exo-S?
Aki: cost was $627M w/Launch vehicle
Scott: lots of interest in Exo-S and Exo-C, but not one of the 4 missions. Suggest this goes into a Probe class, and our report appendix have a section on probes.

Dave: change in WFIRST implementation may be much more expensive if we wait until the next decadal survey
Aki: the changes are minimal, and probably can live with no change, but need orbit to be L2. When is the deadline for WFIRST orbit decision?
Dave: mostly done with study, mild preference for L2, political side, Grunsfeld seems more interested in Starshade than servicing, so L2 may be preferred.
Scott: if there's consensus for WFRIST to be compatible w/Starshade, that we put that in our report
Shawn Domagal-Goldman: Scott, if I remember right everyone had WFRIST-starshade in their "matrix" of suggestions at some level at the in-person SIG meeting at JPL.
Scott Gaudi: Shawn: agreed
David Bennett: If we are going to make any change in the WFIRST instrumentation, we should get some sort of peer review report telling NASA that this is a priority.
Aki Roberge: Paul Hertz seemed unenthusiastic about taking much action on WFIRST-S before the official decadal process.
Shawn Domagal-Goldman: Also, it should be noted that the Exo-S Final Report examined the science that could be achieved without any changes to the WFIRST instrumentation
David Bennett: Aki, it definitely complicates things for Paul, but if it is important for the starshade, we should speak up anyway.

Organization for Joint Report

Avi Mandell: for the Joint report, for flagships, there should be discussion on science from all areas. There should be a discussion that is separate for the individual PAGs.

Should we Add Missions to the Set?

Scott: should we add more missions?
Aki: don't think we should add missions. Budget is fixed. Other large missions (DPFI, SuperTransit Characterization) not supported. IR Interferometer would be useful for follow-up characterization and large apertures should be able to do Transit Characterization (>8-meters).
Scott: agreed, people have mentioned only 3 other missions: TPF-I, ECHO, Astrometry Mission (a la SIM)
Nick Cowen: on the timescale of this decadal, I am interested in technology development for e.g. TPF-I for a future interferometry mission.
Shawn Domagal-Goldman: I agree with Nick entirely. I'm a HUGE fan of TPF-I, but it's not ready for this decade and I wouldn't be in favor of studying it now.
Shawn Domagal-Goldman: However, this is one of the ways a Far-IR surveyor would be beneficial to our community, depending on what architecture they select.
Natalie Batalha: I agree, Shawn, with regards to the Far-IR surveyor. I'm anxious to see progress with interferometry missions leading up to the exoplanet mission we want some 20-30 years down the road.

Limits on LUVOIR

Avi Mandell: LUVOIR segmented would naturally be JWST sized, so at least think about a lower bound as 6.5m aperture, clone of JWST
Aki Roberge: We're also thinking about pushing LUVOIR to as long wavelenghs as possible.

Scott: limits may be because of single aperture vs. segmented
Avi: monolith absolute largest size needs to fit in SLS, which only fits 8m, segmented goes larger

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Should we Merge Missions

Scott: should we merge missions
David Ciardi: not unreasonable to specifically list where science cases can be merged. Ok to have science cases that can be done by 1/2/3 of these missions.
Scott: how do we phrase science that's consistent and coherent across the missions, how should we structure this?
David: drawing a clear understanding of probe vs. flagship capability, lot of science with the probes, more affordable, but does not get everything we want
Shawn Domagal-Goldman: The point David is making for probes vs. flagships is critical, IMO.
Scott: there's a range of science possible, but there's a step between flagship and probe in terms of risk, cost, schedule, etc. What we struggle with is how to balance the range, how to organize the teams such that the decadal can balance best.
Avi Mandell: The key is that you want a "apples-to-apples" comparison. This will be critical to avoid dissension and fragmentation in the overall Exoplanet community. If we're clear on science, it'll help focus us. Worried previous decadal was "just want answers for everything"
David: it's really important for us to make sure we don't forget the top guiding principle, which is what the top science question we're asking
Daniel Apai / UA: I agree with Avi, that is important.
Scott: this is the "what is the minimum interesting science question we want answered"
David: we could ask a question that cannot be answered.
Shawn Domagal-Goldman: It should be the minimum increase in our science knowledge compared to the next "bin" down.
Shawn Domagal-Goldman: There may be science questions worth asking/answering that could also be accomplished for less, for example.
David Ciardi: @Shawn - I agree ...
Bertan: it comes down to quantifying the mission, 1 important input is having a solid reference DRM, with consistent science capability/yield curve
Scott: we have to agree on the curve, with consistent ways to calculate, this hasn't been the way Exo-S/-C were orgnized, so they are difficult to quantitavitly compare.

Sally Heap: Is there a case to be made that a LUVOIR extended into the IR could be used to characterize transiting planets?
Aki Roberge: Sally, yes, we think so. But not too far into the IR.
Avi Mandell: Simulations suggest a 5-micron cut-off will give good transit science even for a room-temperature telescope
Sally Heap: I was thinking about extending the max wavelength to 5 microns
Eric Agol: How long, Aki?
Aki Roberge: What Avi said. ~ 5 microns.
Aki Roberge: But only for transit spectroscopy, not direct spectroscopy. The latter probably will cut off at ~ 2 - 3 um.
Avi Mandell: (probably more like 2, or 1.8)
Aki Roberge: TBD
Shawn Domagal-Goldman: I agree with your assessment of what I said :)

Eric Agol: So the coronagraph would not operate out to 5 micron?
Sally Heap: Since the inner working angle tends to scale with wavelength, a coronagraph operating at 5 microns would not be attractive.
Avi Mandell: But you could make an argument for longer-wavelength coronography for non-exoplanet work, such as disks...

How to Organize STDT

Avi: On the STDT structure, we spent lots of time/effort getting ExoPAG and COPAG to agree, having a single STDT is the best way to achieve consensus. If we have a team for HabEx and for LUVOIR, in addition to camps of people, then there may be a perception that LUVOIR is an IR mission that happen to have exoplanet, and vice versa. Ultimate concern is having as much unity as possible. Have the conversation with the cosmologists about trades. This is more about social engineering.
Scott: main goals is not to fracture the community. Let's think more outside the box about how to organize. The obvious is to have 1 team or 2 teams. Maybe there are other possible solutions to prevent facturing?
Avi Mandell: One science team and 2 engineering teams!
Scott: the technology range is so great that trying to study with 1 team may be too much
Natalie Batalha: Seems there is consensus on the science goals. If the STDT is split into two, I wonder if we set up a dynamic whereby each group falls into the trap of advocating for their particular project instead of looking for the most effective way of accomplishing the science objectives that we all agree on.
Alan Boss: According to Paul Hertz: "A Science and Technology Definition Team (STDT) will be appointed for each mission concept study selected by the Astrophysics Division Director. "
Natalie Batalha: Yes, Avi: subcommittees of one team working, each working on different teachnology aspects.
Daniel Apai / UA: I suggest two STDT teams but with a few shared members.
Avi Mandell: Daniel, I see your point, but I think the overlap between HabEx and LUVOIR is so significant that you'd have a huge overlap, in both exoplanets and astrophysics

Rus Belikov: are the mission parameters that are set? E.g. do we have range of sizes, is HabEx for sure monolithic or not?
Scott: no, it's up to us, no firm guidelines
Rus: seems like HabEx is a downscope of LUVOIR, should we treat it as a downscope? Then no need for 1 or 2 teams
Aki Roberge: What Rus said!
Aki Roberge: HabEx is a small LUVOIR
Scott: don't agree, they are pretty different, HabEx is focused on exoplanet
Avi Mandell: I disagree! Engineering is completely different for monolith vs segmented
Avi Mandell: So engineering effort should be separate
Rus: if we're in a scenario where we have to downscope, then community may want to consider HabEx
Gabriel Rangel: (Bertrand): 2 design teams required for sure. Possibly 1 science team.
Aki Roberge: The LUVOIR in the Roadmap was monolith OR segemented.
*David Ciardi: @Aki ... I think HabEx *could be* a small LUVOIR if designed in the right way*
Scott: obvious solution would be 2 design teams, should LUVOIR become unfeasible
Shawn Domagal-Goldman: That was one thing that there seemed to be consensus on at the last meeting - that Hab-Ex is likely less capable than LUVOIR would be, based on their descriptions.

Aki Roberge: But I agree, the technology differences between monolith vs. segmented are significant -> design teams. But the science is more of a continuum.
Avi Mandell: Exactly!
Aki Roberge: -> 2 design teams

Charles Lawrence: advocate position for 2 studies, but emphasize goal of common understanding, or common points of technical and science goals. Best way to achieve outcome we want is with 2 studies suitably defined. Range of technology/science is large, number of options is large. The Range one can study in 1 team is limited. LUVOIR should start being broad range, if HabEx is optimized for Exoplanet, then you already have a different fundamental design driver. At the end, you come up with warring factions that disagree, so the study must be organized and executed with agreement. We'll get more from 2 cooperating studies.
Scott: I'm hearing agreement that the science yields should be evaluated consistently. We also want to make sure technical requirements in common are evaluated consistently. But technology requirement is broad enough that it may not be able to be done in 1 team.
Gabriel Rangel: (Bertrand) common Exoanets + general astro science team, and 2 design teams generating input for mission instrumental parameters to be folded in a common science yield estimation
Avi Mandell: Yes!

Jim Kasting: it seems a single committee can study a big version and a small version should that be necessary, cohension over division.
Natalie Batalha: What Jim said! That was my earlier point as well.
Chas Beichman: at least have 2 design teams, we all love LUVOIR, but may be quite expensive, and these missions may come at 2 different price points. Having 2 distinct missions is good, as two distinct end states that are well defined for the Decadal to consider.
Shawn Domagal-Goldman: So far, I've heard a LOT of agreement that we need two design teams. (And I meant to indicate that when I spoke, as well.)
Sally Heap: I'd like to suggest a different tack: to summarize the science we want to accomplish, and then summarize the technology that needs to be developed before committing to a specific type of telescope.
Bertran: there needs to be a referee, and the referee needs to have a clear way to evaluate science yield, we don't let LUVOIR get too small, not let HabEx get too big.
Shawn Domagal-Goldman: But there also seems to be a significant amount of agreement (although not unanimity) of having one science team.
Scott: but we have a short timespan, having joint meetings are important or having a referee.
Shawn Domagal-Goldman: I also have noted that everyone (I think) agrees there should be at least some small amount of overlap in team composition. The question is how much over lap.
Gabriel Rangel: (Bertrand): agreed

Aki: there are real differences in technology in size scale, so 2 design team seems necessary. But the science is more a continuum. With Exo-S and –C, we just tried the common yield analysis, even with best intentions, if you don't start with the same ground rules, it seems not to work as well and things diverge. Ways to determine yield was easier for 1 team rather than other. So it seems easier to have 1 team do the yield, same people. 2 design team, 1 science team.
Shawn Domagal-Goldman: As a fellow Exo-S team member, I agree with Aki's assessment.
Avi Mandell: I agree as well (even though i wasn't on the teams)
Natalie Batalha: I agree with Aki: one science team, two design subcommittees.
Avi Mandell: I don't agree with referee team!!
Avi Mandell: Will lead to arguments, not negotioations

Scott: may be difficult to decide on the science to cross that many orders of magnitude
William Sparks: can someone clarify if there is a consensus that LUVOIR can do HABEX but not vice versa?
Shawn: both HabEx and LUVOIR are going after the same kind of science, like to have 1 team to look at both, because there will be downselects, with different trades. So if there are 2 designs, presumes there are already trades that gets you in the cost box. Good technical reason not to split the teams. The main driver behind HabEx is concern that LUVOIR won't be doable, and there may be more than 1 way to achieve that.
Bill Purcell: Is there some way to develop a "figure of merit" for the scientific objectives which could be used to evaluate various design options (including HabEx vs LUVOIR)?
Aki Roberge: Bill, that's harder than you think to actually achieve. Lots of assumptions, different possible methodologies.
Aki Roberge: We tried for Exo-S and Exo-C.
Chas: this time around we seem to have a lot more agreement, direct imaging mission, we're haggling over the price, the danger of fragmenting the exoplanet community is a lot smaller than before. We have to set appropriate thresholds for HabEx, and the Exoplanet community will come together and decide what that minimum threshold is. The fracturing could be between the exoplanet and the other larger astorphysics community. We've heard that LUVOIR is the one that will make the advances. Reason for 2 science teams, LUVOIR is much broader.
Avi Mandell: Agree with Chaz on that -- fragmentation between exoplanets & astrophysics is a big risk

Shawn Domagal-Goldman: My hand is now lowered, but I want to say I wholeheartedly agree with Chas on the risk for community fracturing being much lower than it was last decade.
Rus Belikov: Bill, I think the choice between HabEx vs. LUVOIR would (to first order) come down to available budget and not science figures of merit
Sally Heap: My suggestion is to have two science teams, as the COPAG science objectives are different from a those of the ExoPAG. Each science team needs to identify the technologies that need to be developed before we can credibly present the case to Astro-2020. Our recommendation to Paul Hertz might be to put a lot more money into technology development in FY16-FY19.
Alan Boss: I agree with Sally, though with some overlap of the two science teams.

Charles: we need 1 yield calcualtion that everyone can agree with. That can be thought of as an independent activity to the science teams.
Scott: you can imagine a referee team doing this, much like what happened with the AFTA coronagraph teams that predefined the parameters and evaluate in a self consistent manner all the yields and what the technology maturation assumptions are.
Avi: I disagree with this referee idea, it's much more than a yield question, it's a belief in what can be done in an apples to apples, e.g. what general astrophysics can be done from 1 method to the other? And then it extends to pretty much everything else. It makes things more complicated than it has to be.
Aki Roberge: What Avi just said!
Charles: there are many points that need to be common. We should not be thinking about this only frm an exoplanet perspective. We're advocating things that are apples and oranges. The breadth of LUVIOR science will be different to HabEx. I've watched lots of mission design, there is a real difference in how design teams work if the submission is cost constrained from the beginning and if it is not. LUVOIR should not be cost constrained, but HabEx should go into the design with cost constraints or points in mind.
Jim Kasting: Yes, I'm with Shawn and Chas. I think we'll end up with a direct imaging mission no matter what.

Jim Kasting: Note that the minimum science requirements for a Habex mission have already been fairly well laid out. We did this on TPF-C ten years ago.
Aki: there is now a referee doing analysis on the Exo-S and Exo-C results, and no matter what the referee team says, the two science teams don't seem to agree with the referee team. It doesn't seem to be working.
Scott: but there's gotta be a way for folks to agree on a set of assumptions. "It's just math"
Scott: these are two very different missions, the job of the referee is not to evaluate the science, but to say, given these requirements, what is the yield. Given these TRL, what is the technology required? These missions are different, if it gets combined into 1 team, then inveitably you'll get pushed into an astorphysic optimized to planet optimized. So split it already. Saw this exact issue in the WFIRST science team.
Avi Mandell: Where did the cost cap come from??
Scott: our job is to get the information out, not to get the cost cap etc. firmed up.
Aki: one of the reasons why we lost in the last decadal is because we had multiple options. I was hoping we can put forward a consensus option from the community. We don't want the exoplanet science getting pushed aside by general astrophysics.
Scott: we don't know what is feasible yet, so we need to get the science defined and the two end member designed.
Avi Mandell: Or at least a ranked list...
Sally Heap: The COPAG and ExoPAG have different scientific objects, but both groups long for a large telescope because the interesting targets are faint. Couldn't both groups get help from a single telescope technology team?
Alan Boss: As someone who was a part of the crucial votes for Astro2010 EOS, the real battle was between WFIRST, SIMLite, and IXO. Only the rank ordering of the top three mattered. In the end, only the top ranking mattered, i.e., WFIRST.
Chuck: advocate 1 science team with 2 design team
Dave: handle this with an AO for the selection of the science teams. People can submit proposals.
Aki Roberge: Interesting suggestion, Dave.
Steve Unwin: 2 separate design and science teams, so we get two places in the design space with costs defined. If you combine them, can't cover as much space. 2nd point is about probes, not mentioned, a probe that is scaled down HabEx is easier to think of rather than a scaled down LUVOIR. There may be a 3rd point.
Aki: we have Exo-S and –C, what else needs to be done?
Steve: perhaps only scaling relations with building something intermediate.
Aki: pretty sure anything more than Exo-S and –C will go out of probe class.

Amy Lo: Current summary of options:Agreement on design team: 2 engineering/design teams for HabEx and LUVOIR. Science team options: 1) 1 integrated science team; 2) 2 separate science teams; 3) 2 science team with a referee.
*Shawn Domagal-Goldman: Amy, it's also worth pointing out that everyone seemed to agree that there should be *some* overlap if there are two science teams.*
Natalie Batalha: Amy: I don't think number 2 is an option. There must be some kind of integration either by having an umbrella science team or by having a referee team. Perhaps Shawn was implying the same.

Revised summary of options:
Agreement on design team: 2 engineering/design teams for HabEx and LUVOIR

Science team options: 1) 1 integrated science team; 2) 2 separate science teams with some shared member/overlap; 3) 2 science team with a referee. Option 2 and 3 may be merged into a single option.

JWST Lesson

Phil: lessons learned from design teams for JWST. It's important to have a lot of buy in from industry. Started by funding 3-4 industry teams and then downselect to 2. Programmatically, start with 3-4 industry design studies and ask them the following 2 questions: 1) in order to do all the LUVIOR science, how much money and when is the launch? Then, ask them 2) for $5B, what can you do when? The only way to make progress is to have competition, start with 4 then downselect to 2, and then to 1.

Technology Development Support

Shawn: support technology development for TPF-I, should be something we note, so there should be something applicable for the Far-IR surveyor.
Scott: no reason not to include that.

Support for X-Ray mission

Aki: have we heard anything on how the x-ray is applicable? Do we need to?
Scott: we are required to.
Shawn Domagal-Goldman: I guess knowing the X-ray inputs to planetary atmospheres would be useful? (I'm streching here.)
Shawn Domagal-Goldman: Yes, what Scott is saying.
Aki: can we say we have no interest?
Scott: we can say that, but in the spirit of harmony, we should support it unless we think there's another compelling mission to kick the X ray out.
Aki: is there an advantange to shove X ray surveyor out?
Shawn Domagal-Goldman: We can state this discussion Aki and Scott are having - the X-ray sureyor would give us data on high-energy inputs to exoplanet atmospheres. However, UV data are likely much more important data for that science case.
Alan Boss: Evgenya Shkolnik studies exoplanet magnetic field interactions with host star field via x-rays. X-rays are also of interest for habitability for M dwarfs.
Scott: If we don't have a super compelling mission to add, so why put the X ray mission down? Best for harmony to just say it doesn't do a whole lot for us.

Probes, do we recommend them?

Scott: There's a pretty broad contingent that agrees probes are interesting. E.g. Starshade for WFIRST. But there's no funding line for Astrophysics probes, which is a problem. Ask NASA to add a probe bucket? There are also specific ideas that NASA should study, Starshade for WFIRST, CMB polarization, Gravitational Wave STDT to prepare NASA for ESA mission preparation. What we need to decide is a) do we want to encourage Paul to study probe class missions? B) if so, how many probes? C) in what way should he study them, d) specific missions to advocate?

Josh Pepper: should our attitude on probes to be addition to HabEx or LUVOIR, or a compensating mission in case neither wins?
Scott: good question, depends on what we think the budget is. NASA budget has been flat in the last 10 years, so where is the probe money coming from. Do we assume bottom line is zero sum or additive?
Steve: once the HabEx team settled on their design, they should consider a probe class mission. Don't think need a separate probe version.
David Ciari: be aware of supporting something expensive/large and it takes so long that the field goes right past us. Small things are attractive because some real science can be done faster.
Dave Bennet: decadal has a medium class, that seems to fit the probe very well. Equivalent to Discovery. Establish a separate class.
Alan Boss: In Astro2020, the Exoplanet Mission that was recommended was essentially a probe-class mission. It was bigger than the "medium-class", which is where Explorer-class falls.
Alan Boss: oops, make that Astro2010 -- Freudian-slip!

Charles: In order to get a new program, you have to have a lot of things lined up. Without support from Decadal, it's nearly impossible. In order to have a probe class line, Paul said he needs to have a a) recommendation from Decadal, AND b) he needs a flagship that doesn't eat up so much money. The probe argument for the Decadal is here is a wide range of possibilities, don't pick one, but have the opportunity. Don't have to study the probes in the same way, but make the argument that the class needs to exist.

Amy Lo: the very next discovery call eliminated all Exoplanet science...
Shawn Domagal-Goldman: Discovery: $450M cost cap, proposed mission on any topic
Shawn Domagal-Goldman: New Frontiers: $1bn cost cap, but you can only proposed on missions on a subset of science goals defined in the decadal survey and mid-decadal review
Alan Boss: In Astro2020, the Exoplanet Mission that was recommended was essentially a probe-class mission. It was bigger than the "medium-class", which is where Explorer-class falls.
Alan Boss: oops, make that Astro2010 -- Freudian-slip!
Bill Purcell: Isn't one of the issues trying to keep the JWST funding wedge within Astrophysics?
Scott: nominally yes, it's going to WFIRST, at least that's the plan from Paul
Bill Purcell: I've heard Europa has eyes on it...

Chas: we can propose NASA invent an astrophysics equivalent to New Frontiers. We can have the entire decadal committee backing this recommendation.
Scott: Paul does want something on Probe class missions, should we say something about the CMB polarization and Gravity wave probe missions?
Chas: personally I'm agnostic about the rest. For ExoPAG, are there niches where a probe would do something valuable. Echo/Finess following Plato? Or Starshade-AFTA, Astrometry mission? We should address that directly. Maybe we solicte a white paper on each of those three.
Scott: we could say in the report that NASA should look at a specific funding line and here are examples of missions that will fit into there.
Natalie Batalha: Perhaps an interferometry pathfinder would also fit within the probe-class or New Frontiers box

Aki: play devil's advocate, is there risk to the flagship budget with the probe class line?
Scott: yes, if you think it's a zero sum game
Alan Boss: Actually, even Explorers fell in the "large-class" in Astro2010 -- the "medium-class" was limited to $200M or less, e.g., technology development programs.

Shawn Domagal-Goldman: We have to be careful here.
Shawn Domagal-Goldman: There are implications with how we make this recommendation. (came on voice) In an ideal world, we would have an equivalent to Discovery and New Frontier which have their own budget wedge and cadance, with Discoveries a few per decade. Ideally, we should have recommendations that if the flagships don't go, then we recommend the probes etc.
Shawn Domagal-Goldman: Just to put my sentiment into words - we have to specify details with "New Frontiers for Astro" type suggestions. What's the cadence? What's the cost cap? What's the list of science cases people could propose to address? Would there even be such a list? Etc...
Shawn Domagal-Goldman: I also want to ensure that we keep our discussion here on the exoplanet advantages/disadvantages to such a recommendation.
Scott: for the purposes of this particular report, is whether we think there may be compelling science to consider creating this line. At least the Starshade for AFTA there is compelling enough science that we may want to do that.

Chas: it's a science question we really have to assess. LUVOIR people, Chris Stark, have a good science case they put forward with 100 detections etc. Is there another science case that we can put forward that is compelling?
Charles: I thought this is what we're talking about with yield
Chas: the yield question is mechanical. This is "what is the science goal we as an exoplanet community is setting for ourselves".
Scott: part of this is dependent on whether you want the pale blue dot, or green slime, or exoplanet formation

Bertrand: are we going to be like CoPAG and have white papers to Paul's charge?
Scott: several white papers already address the issues. Don't think we need white papers because the community is small and don't need to canvass the community that broadly. We all basically agree what needs to be done. Haven't heard anything wildly off the charts.

Natalie: it's not clear to me the science objectives are well articulated yet. We all want R=70 spectra of 50 earths, I share concern that HabEx can't get us there. So we need to get a flexible portfolio together to prepare for that. That's why the probe class mission lines are out there. But the challenge is to get the flagship we want and the probe class mission. Echo/Finess, Starshade, interferometry. Doesn't seem to be doable without the probe class line.
Scott: yes, consensus on diverse portfolio

Aki: Chris's analysis says something like spectra of 30 exo-earths is statistically getting 1 that will be habitable. The question is how can we live with… 10? 5? The uncertainties in the astrophysics parameters says 8 meters to 12 meters for an internal coronagraph. He's adding starshade calculations, and we can see already it's limited by fuel. How few earths can we live with?
Scott: for the purposes of this report, this is not a decision we have to make.
Natalie Batalha: "The yield is a continuum," says Aki. Yes, but at some point, as we descope other science becomes more compelling.
Aki Roberge: Natalie, yup. I just don't exactly know yet where the break point is.

Chuck: if we're going to push hard for a HabEx, how will LUVOIR get the requirements for the exoplanet science?
Scott: we agree both should be studied with different technology teams, disagreement on science team.

Chuck: how do we input requirements to the other study, is ExoPAG going to input requirements to the LUVOIR study?
Scott: we envision LUVOIR is going to image X earths, how that relates to technology is the STDT's job. If technologically feasible, should enable transit spectroscopy
Gabriel Rangel: (Bertrand): in case of non detection of habitable planets, the question is what upper limit on the true fraction are you ready to live with? 1%, 5%?
Aki Roberge: Bertrand states it well.
Aki Roberge: Or Gabriel, I'm not sure.
Gabriel Rangel: Bertrand using Gabriel's computer
Rus Belikov: I would adjust Bertand's statement to "fraction you are ready to pay for"
Rus Belikov: 5% may be more attractive than 1% if significantly cheaper
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End of meeting

Attendee List from Chuck Lillie:

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Telecon Participants

Aki Roberge	Howard MacEwen
Alan Boss	James Breckenridge
Amy Lo	Jim Kasting
Avi Mandell	Joshua Pepper
Bill Purcell	Keith Warfield
Charles Lawrence	Mario Perez
Brian Jackson	Martin Still
Charles Lillie	Matthew Bolcar
Chas Beichman	Nick Cowan
Daniel Angerhausen	Phil Stahl
Danial Apai / UA	Ravi Kopparapu
David Bennett	Roger Lee
David Ciardi	Rus Belikov
David Latham 2	Sally Heap
Eric Agol	Scott Gaudi (Presenter)
Gabriel Rangel (Host)	Shawn Domagal-Goldman
Geoff Bryden	Steve Unwin
Giada	Steve Warwick
Glenn Schneider	Vladimir Airapetian
Harley Thronson	Wiliam Sparks
Hiroshi	