

This document is for collecting comments on the CF06 topical group report. Please add comments below using the following template. Add new comments at the top of the comment list (reverse chronological order).

When commenting on specific language in the draft, it is most useful if you can provide the line number and the text of your suggested change.

We will try to address comments as we receive them. In some cases, the comments need additional thought or discussion. In these cases, we have highlighted our response with a red **TODO**.

Name <email> (YYYY-MM-DD)

- General comment...
- L100: Comment with line number...

Suvodip Mukherjee suvomu@gmail.com (2022-07-30)

- **[addressed]** In lines 534-538, mention about the cross-correlation of the GW sources with galaxies to measure H_0 : <https://arxiv.org/abs/2203.03643> from LVK GWTC-3
- **[addressed]** In lines 541-547, mention about the measurement of dark energy EoS from the synergy of SPHEREx and DESI with the GW sources: <https://arxiv.org/abs/2107.12787>, <https://arxiv.org/abs/2007.02943>
- **[addressed]** In lines 541-547 by combining different GW and EM probes, One can also test theories of gravity from GW sources for both bright and dark standard sirens: <https://arxiv.org/abs/2012.15316>, <https://journals.aps.org/prd/abstract/10.1103/PhysRevD.97.104066>. Testing theories of gravity is also possible from lensing of GWs: <https://arxiv.org/abs/1908.08951>, <https://arxiv.org/abs/1908.08950>, <https://arxiv.org/abs/2108.10872>
- **[addressed]** You may also consider referencing: <https://arxiv.org/abs/2203.06240> which explores the multi-messenger aspect.

Sara Simon smsimon@fnal.gov (2022-07-12)

- I strongly support CMB-S4 as a high priority in the near-term priorities
- **[addressed +-]** I think the distinction between near-term and long-term priorities is critical for highlighting what should be prioritized first. The draft as-is makes which areas are near vs. long-term clear in the executive summary, but it might be useful to have a rough definition of timeline for near vs. long-term in the text (maybe in the titles on Lines

35 and 47). This is captured in the figure, but some rough numbers in the text could be useful as well.

Eric Linder evlinder@lbl.gov (2022-07-12)

- **[addressed]** Lines 52-54: There is a breakdown in parallelism in the major recommendations. While the first and third one under Longer-term Facilities are properly agnostic, saying “a Stage 5 spectroscopic facility” and “line-intensity mapping”, the second one calls out a proposed project concept by name “the CMB-HD concept”. For consistency one should say “a Stage 5 CMB survey” – even better would be parallelism with LIM, as “A wealth of fundamental physics can be probed by a much higher resolution and lower noise wide-area CMB survey. However, the technological readiness of this program must be further demonstrated before the community is prepared to invest fully in a large-scale project using these technologies. Thus, we recommend a coordinated program of R&D to advance the technical readiness of this concept.”

Yuanyuan Zhang ynzhang@tamu.edu (2022-07-12)

- I am really happy to read about the importance of Cross-Survey Analyses and the advocacy for measures strengthening those opportunities.
- **[addressed]** Regarding one of the advocated measures – “New initiatives enabling joint analyses:” and “consideration of new centers” – I strongly support this advocacy. Relatedly, in the CEF frontier DEIA discussions, cross-institutional collaborations (including scientific collaborations often established around cosmic surveys) have been identified as weak points, as well as very valuable opportunities, in promoting a more equitable scientific community and addressing scientists’ misconducts/abusive behaviors, because of ambiguities in accountability policies/structures. It could be really neat to add a reference to the CEF DEIA white papers (e.g. arXiv: 2206.01849, arXiv:2204.03713) on this issue, and incorporate “Support for a healthy and equitable collaboration community” emphasizing the importance of supporting scientists and a healthy community (some of the CEF DEIA white papers for example are already calling for “centers”/funding agencies/professional societies to help enforcing DEIA strategies). It would also eliminate my concern that advocating for further “cross”-collaborations could worsen the problems identified in CEF DEIA white papers.

Bradford Benson bbenson@fnal.gov (2022-07-15)

- **[addressed]** Lines 52-54: I agree with Eric’s comment and recommendation above. I think it’s more appropriate to remain more experiment agnostic in the R&D / next-decade planning recommendations. And I think his suggested phrasing, would be equally as strong to enable DOE to support the R&D / development of a future concept. I also think this re-phrasing would be helpful to not confuse the case for CMB-S4, which I think is a high priority in the near-term priorities (which I believe was the consensus from the group in the last call, at least).

Jonathan Blazek j.blazek@northeastern.edu (2022-07-17)

- Lines 71-73: I know that these summary points are still being developed, but I wanted to advocate for specific mention of joint analysis tools and shared simulations to enable joint analyses (and cut down on duplication of effort). These issues are covered well in the Sec 6.5, and it would be impactful if they appear in the executive summary as well.
- Comment from Tuesday discussion on the question of “what are we asking for” when it comes to cross-correlation analyses and complementarity: As David mentioned, in some cases, it will be collaboration/experiment structure that enables these studies. In some cases it will be making cross-correlation studies **core** science goals of the collaborations. If these studies aren’t considered to be primary, they will always be underfunded (e.g. the simulations and analysis tools needed to do them). As David also mentioned, this won’t always actually cost more in total, since effort can be more efficiently allocated when shared tools are being built.
- Also wanted to second Jeff Newman’s point below about including a bullet point on the value of photo-z training and IA calibration with spec-z samples

Vivian (from the discussion) (2022-07-19) vivian.miranda@stonybrook.edu

- CMB-HD -> Stage-V. Construction readiness was a little too much.
- The Einstein Telescope is already funded - that is why it was referenced instead of cosmic explorer.
- Cosmic Explorer should be mentioned. Upgrades of Advanced LIGO should also be cited as it has a fighting chance to make precision H0 measurements over the next decade. (in the sentence that mentioned the Einstein Telescope).
- Do we emphasize science enough? (that was a question)
- How to include early dark energy - do we include early dark energy or just the statement that we know H0 is not solved by late-time dark energy.

Katrin Heitmann heitmann@anl.gov (2022-07-19)

- **[addressed]** The draft has a bullet in red in the recommendations for long-term facilities: Bullet about LSST operations and Rubin after LSST
- **[addressed]** This bullet should be written; we probably want to break it up into two: one bullet in near term facility as a recommendation for sufficient support for fully exploiting the exciting data that we will receive from the Rubin Observatory
- **[addressed]** Then for longer term facilities, we should call out “Rubin after LSST”; possibly moving some of the text from the top second paragraph
- We should also think about if the science case outlined broadly in the first paragraph should be in bullet form (there is a suggestion in the latex text)

Jeff Newman jnewman@pitt.edu (2022-07-19)

- Apologies that I haven’t been able to look at the report to date; I’m afraid I’ve had my hands full making sure the CF4 report got done.
- I’d like to suggest that the following bullet reference photo-z training and calibration as well as transients:

- We advocate for support of small- and medium-scale projects that enhance the science reach of studies of transients discovered by Rubin LSST and “standard sirens” detected by gravitational wave facilities.
- Example revised text:
 - We advocate for support of small- and medium-scale projects that enhance the science reach of upcoming facilities, including follow-up studies of transients discovered by Rubin LSST and “standard sirens” detected by gravitational wave facilities, as well as spectroscopy to improve understanding of photometric redshifts and weak lensing systematic effects for LSST.
- Better photo-z training will reduce per-object photo-z errors and improve the random uncertainties for a number of LSST probes, especially LSS and clusters. Better calibration of redshift distributions (as well as spectroscopy to constrain intrinsic alignments, which likely can be obtained simultaneously with photo-z training samples) greatly improves systematic uncertainties for LSS, weak lensing, and cluster probes. It thus has at least as high impact as SN follow-up (which is why the CF4 report talks about both needs, highlighting photo-z training possibilities at a number of points).

VM: I am unsure on what to do given Anze and Kim conversation on GW bullet points

Anže Slosar anze@bnl.gov (2022-07-20)

- Figure 6.1 – Please move LuSEE to LuSEE-Night starting its own bar now and operating 2025-2028 and then some further experiment down the line as “Future DA probe” or something. LuSEE-Night is fully funded on both the DOE and NASA side.
- Minor changes to the second part of the para starting in L664

... To assess whether the far side of the moon is adequate to address these issues, the DOE and NASA are collaborating on the pathfinder experiment LuSEE-Night (Lunar Surface Electromagnetics Experiment at Night). This experiment is manifested on the CS-3 mission of the NASA Commercial Lunar Payload Services to launch in late 2025. It will deploy 4 steerable monopole antennas to provide the most precise characterization of the radio sky at frequencies 1-50MHz to date with 20 percent level absolute calibration and a 10^{-3} relative calibration between frequency bands. With data collected over 18 lunar cycles, it will provide measurements of the low-frequency radio sky below 50 MHz, demonstrate the feasibility of Dark Ages cosmology from the far side of the Moon and have sufficient sensitivity and systematics control to exclude presence of a monopole signal at about the 1- 100 Kelvin level depending on the signature width. This is several orders of magnitude above the expected signal yet sufficient to constrain some models predicting non-standard properties of baryon thermodynamics during the Dark Ages.

Alex Kim agkim@lbl.gov (2022-7-20)

L 576: 578: In an earlier VC there was agreement to remove \$ amounts and stick to “small” and “medium”. Flexibility in interpretation may be appropriate at this point.

Comments on the bullet list around L578

I wrote the original version of this list to be balanced between all probes and avoided recommending every interesting idea in the White Paper. I was matching the high-level tenor of the recommendation of the “static probes” section. Now in this new version, GW has 4 bullets recommending a large number of projects. I prefer my previous approach, but if we are blowing this list up, we need to add recommendations for non-GW projects:

- A project for integral-field-unit spectroscopic follow-up on 1-4-m class telescopes of supernovae discovered by Rubin observatory.
- A project for targeted imaging to produce dedicated light-curve follow-up of strongly-lensed transients discovered by Rubin.
- Support for HEP contributions for planned imaging survey telescopes that will provide high temporal sampling of light curves needed for SN science but not produced in LSST Wide Fast Deep.

L578: I feel uncomfortable recommending this one specific implementation idea without a general call for ideas from the community on how to best proceed with optical counterpart finding. Particularly in the Rubin era.

L569: This is too vague and I am not sure this item was flushed out within our subgroup..

Maria Elidaiana da S. Pereira mariaeli@hs.uni-hamburg.de (2022-7-21)

It seems people are commenting on different versions of the paper. There is the pdf that Vivian sent a few days ago and there is the overleaf, which seems to have a couple of new changes in relation to the pdf shared. It will be good if people can indicate which version they are commenting on.

Comment on Alex's comments in the overleaf version:

L578: your first version, which was copied from the transient's white paper could not be here as it was there, since this document should be uploaded on arXiv and therefore, avoid being flagged as plagiarism. That's a practical context about the need for some changes. Second, regarding the GW appearing in many bullet points. You have to notice that GW appears solely in 2 bullets and as an example together with neutrino and quasars in the others. I think that here (in this section 6.5.2) we should have named things clearly, that's why I explicitly added GW's proposals, the topic that I'm interested in and felt comfortable talking about it. Therefore, I do vote for you adding these new bullet points for SN's and it would also be great if neutrino and

quasar strong-lensing people also could do the same. My understanding is that it is up to the conveners to synthesize/generalize our proposals in the executive summary of this white paper.

L578: Well, I guess the Snowmass meeting happening now is the call for the community to give feedback on the optical counterpart finding.

L569: I'm not sure to which phrase you are referring, but for me, the overleaf now reads as *"To benefit from this kind of joint analysis, static and time-domain resources are necessary for developing a new infrastructure for real-time communication between experiments."*. And I read this as creating something more centralized than having several different channels of communication (for transient's follow-up, I could cite for example GCN/TAN network, the SNEWS network, GW Treasure Map, etc).

Now, I want to provide some follow-up to some of the comments that people had so far in the CF discussion at Snowmass.

Sathya commented on the possibility to measure H_0 with GW alone and why this was not in the CF6 report. But, it is there in section 6.7.1.3 in L765 (though, in LISA's context). I'm pretty sure that could be improved and more emphasized. But I want to noticed that, GW specificities (e.g. directly request for support to the next generation GW experiments) were decided by the group (going to the meetings of this report) as a message that we should not emphasize with in this report, since, there was a claim that was covered by CF7.

Someone commented that it seems "there are no other transients" in the report: I, as an ECS (working voluntarily in this Snowmass), have to say that it was already hard to get feedback from the community for the white paper as it is (I'm referring explicitly to CF6 transients WP and this CF6 report since I worked closely with those). I'm not trying to blame people here, since as I said, this is voluntary work and people have time or not to dedicate to it. In summary, I don't think only "lack of communication" but also "lack of participation" was an issue and I hope the community reflects a bit on this. Otherwise, the more the merrier. I would appreciate it if people working with other transients step up and provide feedback in this process.

Finally, in these CF discussions regarding CF6 (but also for other CFs), it seems that Hubble tension/dark energy with GW & transients should have been more explored in the report, which I totally agree with. And I hope we get this reflected in the final CF report with the feedback received during this CSS. From my personal view, some science opportunities were somehow "diminished" in some CF meetings because they are not, currently, supported by DOE. I think that is a mistake, we are here to discuss what would be the best science cases for HEPA, and not the science that has the better chances of being funded by a particular agency.

Alex Kim agkim@lbl.gov (2022-7-2 - addendum1)

L44: Make explicit that the infrastructure also needs support.

To add to my earlier comment on the bullet list around I578. The original list were recommendations that accommodated all the expressions of community interest we received. This new list has turned into a list of the expressions of community interest. Our subgroup did not rigorously assess the expressions of community interest so I think we should avoid specifics in our recommendations.