Small Aperture Telescopes

Note taker: Ben Schmitt
Chat monitor: Joe Saba

SATs Plenary (Tues)

- John presents Plenary slides - no questions.

SATs Parallel (Tues)

1.) SAT PBD Introduction:

OPTICS:

- Keith Thompson brings up optics baseline discussion and moving from HDPE to alumina, etc. Raises thoughts on optics tube lengths in dimensional discussions going forward as optics tube diameters have been focus of discussion thus far.
- Grant asks about thermal performance tradeoffs between HDPE and alumina - Paul describes Lingzhen's thermal loading model for the optics tube elements.
- Jamie asks about GRASP modeling of the SAT lens designs, and Paul describes modeling effort on BICEP 3 and BICEP Array thus far.
- John C. questions why alumina is being considered if HDPE is assessed to have good performance already. Abby mentions the continued need to keep an eye on birefringence and inhomogeneity effects in the HDPE plastic.
- **AI:** Abby to talk to Nick about SO optical thermal loading modeling (1K loading).
- Keith: why is the Alumina so thick? can it be optimized? PB2 used thinner ones. Answer: no much optimization but it more or less made sense. Keith: HF may want thinner ones. Nick: SO used 3mm thick Alumina.
- Brad: Zotefoam scattering - worried? Measurement? 5% scattering. BA number is smaller but will measure directly.
- Jamie asks if curved focal plane design is telecentric - answer is 'yes.'

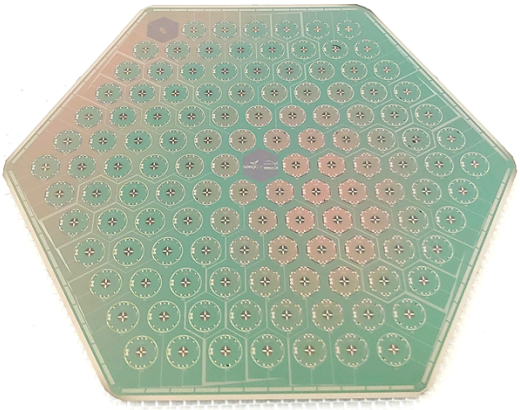
CRYOSTAT:

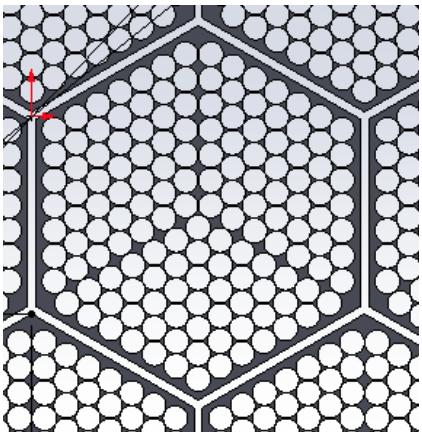
- Paul points out the importance of keeping design compatibility with several of the DR inserts and GHSs under consideration.
- Nick points out that the Janis GHS design example shown in slides has the same systems and components as Bluefors.
- Grant asks if rhombus design is being considered to fill in corners of the focal plane - Joe points out that 12 module layout is what has been baselined, and that focal plane diameter is effectively maxed out in this design layout.

- John K points out that pushing out the space between modules will cost mapping speed.
- **AI:** Need to add to P6 cryostat prototype program - test pre-production modules with readout electronics.
    i.) Paul, added after session: Is there a plan for testing modules/readout with HWP installed in the prototype program? Or is EMI not a concern here?
- Brad: “Zooming in on module, we should also make sure to not have screws poking out above the plane of the horn array, i.e., to interfere / scatter the beam from the horns.”

From Brad: SAT MF Prototype from SeeQC vs Current module spacing.

- Just emphasizing this isnt just a module issue, the detector wafer layout doesnt allow the current module spacing preferred by SAT group, and we additionally need some extra perimeter for horn array and module mounting





<u>Mount and Ground Shield/Forebaffles</u>:

- John C. asks how reliable helium rotary joints are per season/lifetime? Clem suspects that in a few years BA will have a fully proven solution, but already encouraging.
- Stephen P. asks “Just wondering if need/are profiling the turnaround? What's the total time to go from +3deg/s to -3deg/s?” Clem and John point out that cryostat testing effort will include a full SAT1+mount}+readout+etc test that can cover mount performance questions.

<u>Calibration Apparatus</u>:

- Tony Stark asks if calibration apparatus has the ability to be tuned into focus for far and near field beam mapping, etc. Points out that it would be good to be able to move through the focus during testing.
- Keith points out: “re- focus shifting -- Keck (I think, or maybe B2) had one or more "opticians lenses", aperture-sized slightly curved PE lenses to shift the focus around by putting in front of the aperture. Not sure how useful that turned out to be. I made some for B3 for use in the Harvard high-bay (distance to source <

than that to Pole, less than "far field" by a bit), but we ran out of time and they were never tried. Might be useful, not real expensive, one possible option."

2.) **SAT Zemax Lens Design Update:**
- Tony's study of curved focal plane - link
- Joe points out that: "It looks like the nylon filter in the Zemax simulation is in front of the field lens, instead of in front of the objective lens as indicated in the previous presentation."
- Jon G asks what is gained in the optics design through the introduction of the curved focal plane- Fred points out that the Zemax modeling shows that the curved design is necessary and John K points out that f-number variation is improved with the curve design. Tony points out that while there have been alumina lens designs that work with a flat focal plane, HDPE required a curved design.
- Keith suggests modeling flat tiles that are tipped and pistoned as the curved focal plane design is investigated.
- Adrian points out that Jeff McMs metamaterial AR coating process has been conducted on alumina.
    i.) Paul: There have also been questions/concerns about alumina loss and scattering at higher frequencies. We're working on getting detailed cold measurements that would allow us to revisit alumina if the AR coating and loss results suggest it would work.
- Jon G asks about silicon lenses - why is the strehl ratio worse than the alumina. Tony points out that his design will answer this tradeoff.
- Simon Dicker asks "Have you thought of hybrid designs (silicon & HDPE) - if you have to have Nylon in there as a filter can you make it a little curved?" - Fred and Tony point out that it is not being looked at right now, but John K welcomes an analysis that shows a technical advantage of a hybrid design.
    i.) On Simon's question, Keith points out: "At high frequencies we want to minimize the thickness of the Nylon, and I'm not sure how much power you could get out of it and still have acceptable in-band losses. To be studied by someone, if they want to try it. Could also turn the 50K filter into a (modest) lens, also with thickness constraints due to its higher temperature."
    ii.) One place using two materials could help would be to get full use of the high frequency focal plane - on that last silicon design when the last lens has very little power you don't need the refractive power of silicon but the larger diameter of HDPE could be useful (Simon).
- Jon G asks if it is worth it to push for better than 0.95 strehl ratios - John K points out that a reasonable strehl is probably acceptable. Tony points out that more work needs to be done in Zemax on gaussian beam approximations.

3.) **SAT Calibration Hardware:**
- Kirit deferring detailed discussion and presentation on calibration hardware to the next SAT WG call 1.5 weeks from now, but welcomes input from the community

on both the design of the existing hardware scope and other systems or components that might be useful.
    - See Google doc here or slides here for a list of measurements and calibration hardware we're thinking about

SATs Report Back (Tues)

Chat comments and Q&A:

From Zoom chat:

- John R.: Can someone clarify what "adding power to planar filter elements" means? I thought for a minute this was about band-defining filters on the silicon, but I suspect maybe it means the alumina and nylon filters in the tube?
- Paul Grimes: Yes, there was a question about whether we could use IR filter elements as lenses.
- Keith: Adds "Though, technically speaking, doesn't need to be "focussing power", witness the inflection-curved (but zero-power) surface of a Schmidt corrector, but that's pretty unlikely in our case to be very helpful... needs to be pretty far away from a legitimate lens, since we have the freedom to put whatever high order curved surfaces on our lenses."

Lorenzo: Question on module "modularity" - John confirms that the idea that each module will be identical for use, and can be illuminated by optics all the way to the edge of the focal plane.

Zeesh: Does the optics currently not enable readout for what was previously designated as partially read-out modules?
John K: 422 mm circle (really pushing it with Si Lens design) does not allow illumination of roughly half of the outer 6 modules in the focal plane (so we get effectively 9 total modules), but they will be constructed like all other modules as far as readout, etc.

Zeesh: Clarification - are we populating these with readout? Save readout by not populating?

Gunther H - We are reading these out anyway, I don't think we save much.

John R - A good thing to think about. Reading out significantly less could save costs, depending on how we choose to wire things up.

John K - agreed, tradeoff we need to explore (everything designed/fabricated the same v/s custom for cost saving)

Zeesh - Agreed, same design for all modules, but think about readout attachment. As Gunther said, may be cost effective to populate everything anyway.

Brad - Question about f# and pixel design. For new optics designs with potentially changing f-number, are you also exploring changing the horn diameter or pixel spacing? John K: No, not currently, want to understand how much we can gain back in aperture efficiency, but keeping edge taper, by changing horn design. Perhaps could consider changing pixel spacing if it seems we cant meet requirements.

John K - working with baseline design which specifies horn pitch and optimizing the horn design within these constraints.

Brenna F - have you figured out the placement within your optics tubes?
John K - all of the 12 modules within a given tube are identical.