

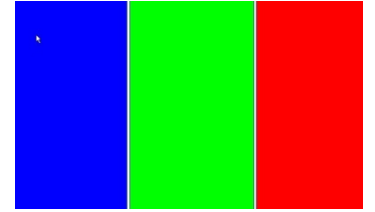


RedGreenBlue Discussion topics

Benno Willke, David Shoemaker



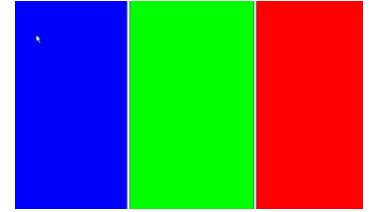
Some numbers (all these slides LIGO-centric, mea culpa)



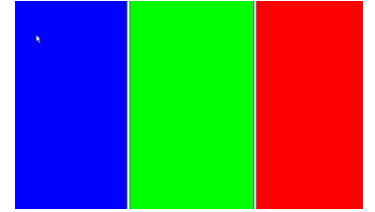
- | aLIGO timeline
 - » 1999 aLIGO White Paper
 - » 2005 Proposal to NSF
 - » 2008 Project start – was made conditional on reaching the initial LIGO sensitivity curve and completing one year of observation
 - » 2015 Project complete
- | And then....
 - » ~2016 AdVirgo-aLIGO first detections (need this to expect a sizable Proposal to the NSF to be taken seriously)
 - » ~2018 KAGRA on line
 - » ~2020 LIGO-India on line
- | aLIGO Costs
 - » ~\$220M USD for entire project, \$205M from NSF
 - » Includes all labor
 - » Includes 3 instruments, data analysis computers, vacuum changes



How did aLIGO go from ideas to execution?



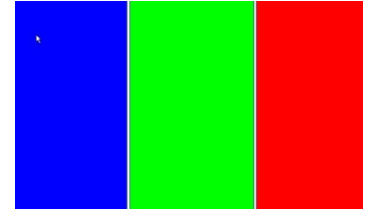
- | Some key ideas had some prototype/parameter experimental verification:
 - » Low-loss monolithic fused silica suspensions
 - » Signal-recycled interferometer topologies
- | This allowed several basic noise sources to be established, and top-level requirements written down – 1999 White Paper ([LIGO-T990080](#))
- | Several basic design questions remained:
 - » Fused silica or sapphire optics
 - » Approach to the high-power laser source
 - » Approach to seismic isolation
- | For each, work continued on several approaches in parallel for some years
 - » Downselects mostly required more than friendly discussion
 - » Transition from a research plan to a detector design
- | So...a key question for this new endeavor: when to start to narrow choices?
 - » ...but first a few more general comments and questions



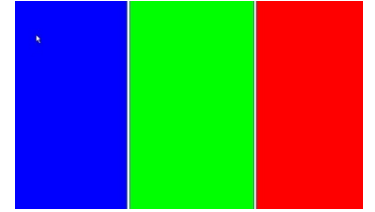
- | Prototypes are very important:
 - » Convincing oneself that ideas are sensible
 - » Convincing colleagues that an approach is basically successful and can be engineered into a 90% instrument availability
 - » Convincing one's sponsor that the proposal is sensible
- | 1) Tabletop proof-of-principle
- | 2) Demonstrating a key parameter at the level required in the final implementation
- | 3) Establishing interfaces, installation procedure, reliability

- | Clearly, modeling must track – the objective is to have a set of reduced-scale measurements, plus a model, that makes a projected instrument performance credible
- | So....

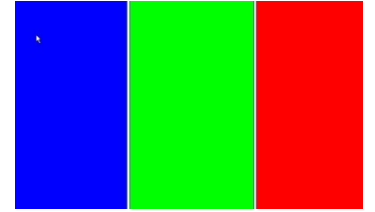
- | What prototyping for each new aspect of the proposed interferometers is needed?



- | What top-level physical constraints are sensible?
 - » Re-use of km vacuum envelope
 - » Re-use of instrument vacuum chambers
 - » Re-use of seismic isolation
- | Target an upgrade of Advanced LIGO (Virgo, etc.), or form the basis for a truly new generation?
- | Should we plan on complementing aLIGO with second detectors – Xylophone?
- | How to arrive at a reasonable cost envelope?
- | How can the project be re-scoped at a later point to ...
 - » adapt to available funds and observational criteria?
 - » respond to successes and failures of development of elements of the design?
- | How long will the instruments be unavailable due to the upgrades? (shut down one LIGO instrument for a year or two, then the other? Network matters!)
- | Incremental vs. wholesale changes?
 - » ...but next, narrowing choices



- | A \$50-100M proposal will require that detections have been made
- | Earliest is 2015, could be 2016, or 17...
- | A goal to have a proposal ready in ~2016 means..
 - » 2015 engineering study, cost and schedule baseline starting
 - » 2014 all design choices made
 - » 2012 Project identified – White paper exists, a few choices remaining
- | When would this instrument start operating? Some optimistic guesses
 - » 2016 proposal
 - » 2017 approval (aLIGO etc. full sensitivity, having made many detections)
 - » 2019 engineering done
 - » 2021 hardware available, ready for shutdown of one or more Observatories
 - » 2023 installation complete, start of integrated testing, then tuning
 - » 2025 observation...
- | ...an argument to create even a grander vision, and propose ET?
- | ...or, the smaller/simpler the upgrade, the shorter the process...



- | Implementation strategy
 - » Small cost: faster proposal/funding cycle (to the point of being covered by Operating budgets of observatories)
 - » Smaller technical scope: quicker R&D/engineering cycle
 - » Short interruption of observation: slips in when ready, between runs
- | Obvious disadvantages: smaller steps forward, probably poorer end sensitivity
- | A number of technical candidates at hand
 - » Improved coatings on existing substrates
 - » Squeezing with no filter cavity
 - »add in the filter cavity...
 - » NN sensing array
 - » Extend suspensions, larger masses (starting to be ambitious!)
- | **As Ron Drever often said: there are lots of possibilities.**