Realizing a complete detector Planning, organizing, execution (Shoemaker)

Chapter:

* is a set of generalizations based on the initial and advanced GW instrument experience, with aLIGO as the ‘case study’ –
* the experience was in the US system, and may have significant differences from other environments.
* Lessons were learned through mistakes – this is what we might do if we were doing it again.

Research to improve instrument sensitivity is continuous

Need to recognize when confluence of elements is present:

1. Astrophysics within reach of concepts
2. Key instrument design concepts prototyped
3. Support from funding agencies within reach
4. Community committed and robust
5. Timing consistent with other constraints – e.g., observing with present generation of instruments

Time scale of a decade between this point and time of substantial hardware and/or infrastructure realization for a full-scale project, and 1.5-2 decades to an astrophysical tool

Consider alternatives to as-soon-as-possible full-scale stand-alone projects

* Why? Lower cost thus threshold for funding; quicker realization; maybe more integrated astrophysics per decade
* Ways to break down the changes to allow interleaving with observation on a given instrument
* Interleaving downtime for instruments around the world
* Delays to allow more instrument research, more astrophysics to inform instrument design
* Collaboration with larger groups – e.g., one design for the world, shared development and fabrication

Establish system performance model with good experimental basis

Work with technical leaders to find natural basis set of subsystems

Start to form conceptual design groups for each subsystem

Identify any elements not present in ‘organic’ team; address shortcomings early, e.g.,

* System engineering
* Project planning
* Infrastructure specialists (e.g., civil engineering)
* Niche technical specialties, e.g., contamination/cleanliness
* Individuals with experience at the Observatories

Brainstorm with one subsystem team at a time

* Elements of subsystem (again a good ‘basis set)
* Cost guesses for each; identify weak points
* Both Key Personnel and general skills needed to get to Final Design
* Time scales; dependencies on other activities; identify weak points

Assemble initial plan, timeline, cost

* Sanity check: is this what we wanted to build? Do we have the money and time?
* Gather concepts into a compact document, float to funding agencies, collaborations

Iterate

* Perform internal reviews
* Respond constructively to criticism
* Pursue weak points in concepts, time scales, cost guesses
* Compare to past experience
* Balance performance vs. feasibility, reliability, cost
* Choose scope, goals vs. promises, milestones carefully
* Consider flexibility, upgrades

Project Management and Reporting

* Why bother, when to get started (pre-proposal!)
* A bit on the fact that it is a complex discipline, distinct from physics
* Descriptions of some specific tools, inputs, outputs
* Technical pitfalls: excess detail, rigidity
* Sociological pitfalls; address communication issues early; disconnects between reporting and reality; credibility required viewed in both directions
* Internal reporting: earned value, technical progress
* External advisory panels
* Risk register and management
* Bug tracking
* Contingency in schedule, cost
* Safety
* Financial/schedule Change control
* Technical Change control
* Team communication, meetings: things to do and to avoid

Form Project team

* Technical: ensure proper balance of engineering and physics
* Management; need experienced Project Manager for almost any scale
* Some hierarchy, rough 10 persons reporting to 1
* Pair engineers and physicists in leadership roles
* Ensure there is existing experience or training of one in Projects – reporting, organizing, estimating, leading; acknowledge burden of reporting in staffing
* Check again if the subsystem basis maps well to teams; adjust accordingly (human interfaces are important too!)
* Seek to make teams geographically co-located; in the measure they are not, plan travel and communication
* Ensure all contributions conform to interface and construction standards

Managing Expectations

* Reporting to sponsors
* Colleagues/collaborators
* Scientific community

Propose to funding agencies, receive funding!

Machinery

* Establish System Engineering team very early
* System performance model: all subsystems to deliver modules
* Plan simulation effort for greatest relevance
* Establish systems interfaces, engineering standards
* Documentation
* Common design tools
* Establish orderly process from concept to engineering, review cycle

Timing issues

* Adjust team sizes and skills to bring designs to maturity quasi-simultaneously, to allow better system trades and reduce later interface problems
* Identify long-lead and high-risk items both in-house and with vendors; consider carefully if parallel redundant paths are needed

Hard decisions

* Organization cannot be a democracy; commitment from individuals and institutions to follow direction
* Choosing between technical solutions
* Caution against boiling frog disease – if there is a problem, address it, don’t wait for it to get better
* Staffing decisions

Transition to Operations

* Sponsor requirements
* Preserve knowledgeable staff
* Pass on ‘ownership’
* Pragmatic documentation

Write books about the experience