Comments: Staged implementation of Advanced LIGO

Adv LIGO Systems 17 may02 dhs

- Nifty idea: a way to soften the shock, spread cost, allow later development of some key items
- Pros (from Peter/Dennis slides, 3 May 02)
  - » Earlier installation of an upgrade with a significant performance
  - » improvement
  - » Shorter commissioning time
  - » Experience with the *'intermediate interferometer'* could make a valuable impact on the remaining *'advanced interferometer'* design
- Cons
  - » Requires a second excursion into the vacuum system to get to the full upgrade
  - » All (or most) suspended optics would need to be replaced for the full upgrade

Earlier installation of an upgrade with a significant performance improvement

- Fundamental notion: that one would observe with this intermediate configuration
- Cradle notion requires significant testing
  - » More of a technology leap than e.g., 10kg to 40 kg monolithic test masses
  - » Would require a test in a sensitive interferometer
  - » LASTI a natural choice, but no results before mid ’05
  - » Glasgow 10m? TNI? Would a scaled test suffice?
- Thermal noise: best data to date from 40m, 10m, TNI
  - » Models still lacking direct confirmation, esp. for composite structures
- Non-stationary noise
  - » The more complicated the structure, the more likely this is
  - » Does bar experience (dead bug suspension) shed any light?
- Bottom line: decision to adopt cradle must wait for testing cycle, possibly with more direct evidence of success than for monolithic mass

Shorter commissioning time

- Certainly true, for the phase of achieving basic functionality
  - » Peter/Dennis assumed initial LIGO laser, sensing/control system
  - » Allows end-to-end test of suspension, isolation – mechanical parts of control system
- Similar to LASTI testing
  - » Integrated mechanical controls testing
  - » More complete, relevant: correct ground noise spectrum, storage times (initial LIGO)
  - » Might allow less *functionality* testing in LASTI, 40m but (re last page), not less *noise* testing
- NB: extensive testing at LASTI and 40m designed specifically to reduce commissioning time
  - » do they serve this purpose well? Any way to increase the value of results from this off-site work – including longer program?
- Installation time: probably no less than current baseline for complete installation; similar risk (fused silica fibers)

Allows impact on the remaining *'advanced interferometer'* design

- Certainly true, if we have a schedule that allows feedback from 'intermediate interferometer'
- Would require ~1-2 years of time after installation of intermediate ifo for changes to be identified and incorporated in final design
- Consistent with (even requires) the notion of significant observation with the intermediate interferometer

Cons noted by Peter/Dennis

- Requires a second excursion into the vacuum system to get to the full upgrade
  - » Given the baseline notion of observing with the intermediate configuration, maybe not a big price to pay – would have to allow a 'significantly' earlier first observation period, though
- All (or most) suspended optics would need to be replaced for the full upgrade
  - » Again, fits the baseline notion – that the final optics not be ready by the first installation
  - » Would the MC/IO optics be final for the intermediate installation?
    - – Lower power operation than baseline design
    - – Using intermediate optics, or cradles, in MC makes the R&D investment for the intermediate interferometer more significant
    - – Any schedule pressure from IO optics?

Alternative staged installations

- Cradle/shell notion, but no performance objectives
  - » See it as a servo and integration test
  - » No performance requirements beyond locking, tuning servos
- Maybe on just one interferometer
- Eliminates the requirement on thermal noise/creep, extensive testing
- Eliminates performance tension: how long to observe? What sensitivity to require? Any signals seen? How and when ask for more money?
- Allows same additional time for ISC, COC, PSL development and testing
  - » Do we need this? Probably nice for COC, others not so sure

Another alternative

- Install complete and final suspensions, seismic
  - » Probably all masses (incl. MC) – height differences, ROC
  - » Initial LIGO sensing/control, PSL as per Peter/Dennis
- No intermediate inventions/testing needed
- Only one incursion into vacuum system
- Cons
  - » Requires sapphire TMs at (present) ‘early’ date
  - » ROC incorrect for cold operation (dynamic range of thermal compensation?)
  - » Transmissions wrong for good sensitivity (but would not advocate performance goals for this stage beyond mechanical shakedown and servo testing)

…and another

- Install everything *but* BSC isolation systems, new core optics
  - » PSL, IO, (many elements of) ISC, CDS
  - » HAM SEI systems
  - » Requires a height, matching adaptor between IO and COC (some temporary optics)
  - » Signal recycling mirror?
- Gets much electronics, detectors, infrastructure in place – our principal commissioning challenge to date in initial LIGO
- Allows more time for COC and BSC SEI development (long poles in R&D or cashflow)
- Provides very well understood 4km cavities for PSL/IO performance testing (but only at >40 Hz, ~6 W)
- Again, no observation goals or performance milestones
  - » Operate optics at 6 W (or a little more? Point of diminishing returns)

Any others?

- Anyone see other Adv LIGO ‘staged installation’ paths?
  - » Observation goals seem to require new SEI
- Staged performance, based on initial LIGO –
  - » Fused silica single (or very short double) suspensions, present TMs (spares), TM magnetic actuators, all on pre-isolators and initial stacks
  - » Present optical/mechanical system, Thermal compensators and intermediate laser power
  - » Addition of signal recycling, maybe change in ITM and RM transmission
- Slippery slope; let’s push for full Adv LIGO for now