Using *siesta* for alignment studies

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What is SIESTA? And where is it?

- A C simulation library, spanning

  - digital signal generation and filtering
  - mechanics
  - optics
  - *GW signals generation*

- An interpreter, which reads a configuration "card" and runs a simulation

- Time domain simulation: follow the evolution of a system over a defined number of time steps.

- At the beginning of each time step, every simulated object is assigned input values

- Results from each object are available at next step as inputs or as results to be output

- Latest version: /virgoApp/siesta/v4r00, see also http://wwwcascina.virgo.infn.it/sDoc/VirgoRe

- Includes an user manual, and example cards.

What is needed to simulate AdV alignment?

A tentative list (what did I forget?):

- Mechanics

  - Updated model of the suspensions
  - *Model for multi-payload suspension, like the BS?*
  - Radiation pressure

- Optics

  - Modal expansion to arbitrary orders
  - SR cavity
  - *Non deg. cavities folded geometry; effective model or simulated mirrors?*

In the following, I classify the tasks to be done as large (> 1 month work), medium (< 1 month), small (~1 week work)

Mechanics

- Current suspension models are 6D

- Forces and torques can be applied anywhere on the SA and the payload: radiation pressure effects can be accounted for

- For each suspension an ABCD model can be output

  – allow MIMO modeling, say in matlab
  – allow using the mechanical model *outside* siesta

- Updates needed:

  – Marionette Recoil Mass: medium task
  – Monolithic suspensions: small task
  – Tilt control, revision of inverted pendulum model: medium task
  – *Multiple payload for BS? medium to large task, depending on solutions adopted*

Optics

- The infrastructure allows to

  – propagate, transmit and reflect beams on optical elements
  – detect beams: signals at DC and modulation frequecies, shapes

- Beams can have an arbitrary # of modes; simulation cost scales as $\#^2$,though.

- Existing elements include mirrors, FP cavities, Virgo (not all input port usable)

- Possible to simulate AdV assembling mirrors and FP cavities; small task, but likely to be slow

- Extending a Virgo model (OPglobal) to include SR:

  – Using infinite lightspeed approximation inside PR and SR cavities: *possibly* a medium task
  – *Unclear to me whether this approximation is an issue (**was not in Virgo**)*
  – Can we decouple locking and alignment issues?

A possible path

- Start by updating the mechanics

  - Can anyway provide black-box suspension models usable in FD
  - Multiple payloads are a complication: urgent to assess whether they are needed from the outstart for alignment purposes

- Update on the optics in standby, until forces are available: then

  - Modify an existing Virgo model to add SR: need to add a mirror and modify the inputs
    * Use infinite lightspeed approximation in the SR and RC cavities: is it sufficient?
  - Explore whether the inclusion of dynamical effects in the SR and RC is affordable

- Manpower for mechanics: AV + help with inputs / validation by PAY and SAT folks

- Optics: AV when free from mechanics. Hope to summon other forces in Firenze/Urbino

  - Help welcome, still to be investigated whether available, especially in new groups