Advanced LIGO
Optical & Mechanical Layout Status

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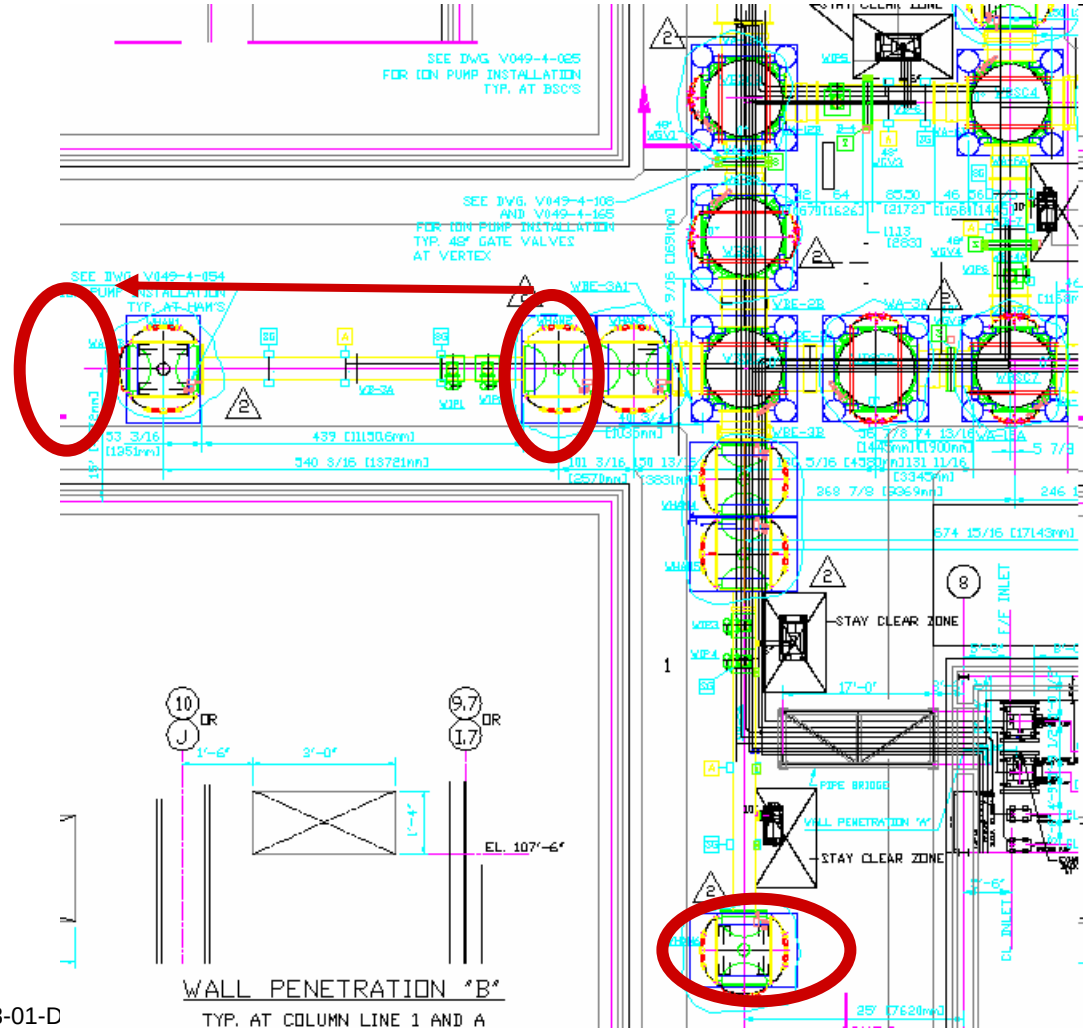
Version -01: with a couple of corrections from the discussion at the LSC meeting

Layout Guidelines

In addition to the layout constraints in “The ADL Optical Layout” (T010076-01):

- Working to eliminate all payloads from HAM2 (HAM8) for the baseline and the stable RC layouts
  - Saves > ~$5M from ADL baseline without HAM-SEI
  - Plan to validate & approve in time for baseline costing (i.e. within 2 weeks!)
- IO Tubes
  - Output tube (between HAM5 and HAM6) likely to remain current diameter (unlike the input tube); Yet to be confirmed by layout checks
  - Input tube to be full diameter with ~12 viewport nozzles (not necked down)
- ISC readouts only in HAM6 (HAM12) or out the -X side of HAM1 (or +X side of HAM7)
  - IFO beams sent to HAM1 (reflected port & BS PO) are relayed out to an ISC external vacuum system out -X side
  - Vacuum chamber (likely HAM2 or HAM8) to be located -X of HAM1 (+X of HAM7)
  - HAM6 (HAM12) to be isolated from the main vacuum envelope with a set of windows on a flange (remove when window backscatter is a problem)

ISC Read-out Tables in Vacuum



Layout Guidelines (continued)

- Non-Folded IFO:
  - IO wants 2 CO2 beams for MMT2 & MMT3 (0.5 to 1 W of heating)
    - UFL will look into ring heaters as alternative -- range of adjustment is 10's of cms in position -- from 85% to 100% coupling -- need ~10% focal length change
  - Optlevs on all suspended optics is a good goal – should have at least a monitor of the optics table, and then use OSEMs as relative sensors
    - Angular damping control (should not be needed for AL) – could also consider using SEI platform sensors instead
  - Need to monitor the input beam position/orientation into the PRM, e.g. partially transmitting optics and cameras
  - IO wants 3 beams (one is REFL) from Faraday Isolator -- tells about polarization state of beam into & back from RM
  - IO beams: 2 MC, 1 Input, could bring laser intensity stabilization beam out as well with assoc. PD
- Non-Folded IFO, stable power recycling cavity option being explored:
  - Use a small beam sample from optic just after the PRM (going toward the BS) instead of BS PO
  - might want longer distance than HAM4/5 folding, so shoot beam to HAM6 & make HAM5 an output detection table -- similar to what we're doing on the input side

Layout Status

- Unfolded IFO:
  - Mike has revised the Zemax optical layout with proper ITM heights, PRC & SRC lengths and then re-imported into SW/PDMW (with chief rays kept in the SW layout)
  - Luke has transferred the IO baseline layout
  - Luke & Mike working on getting readout beams routed to proper “output tables”
  - Luke working on getting IO thermal compensation beams in place
- Folded IFO:
  - The PRM & SRM need to be ~25 mm higher than for the non-folded IFO. Reduced headroom constrains layout – TBD if this is a problem.
- The old AL Optical Layout document (T010076-01) will be revised by Mike & Dennis in April

	Baseline RCs	**Stable RCs**
Non-Folded	Zemax 3D CAD No ISCT, No IO aux	G. Mueller’s optical layout (G050526-00); Zemax TBD Luke’s partial 3D CAD; Merger with AOS in-process No ISCT, No IO aux
Folded	Zemax Partial 3D CAD No ISCT, No IO aux	TBD

Optomechanical Layout

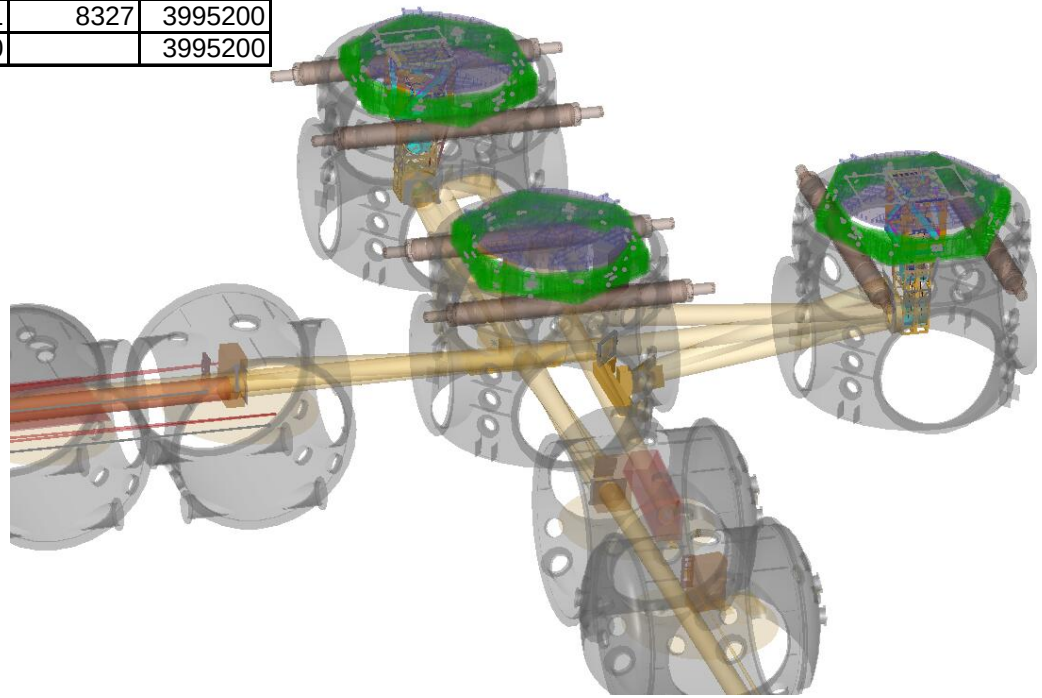
- Maximum Folded IFO Schnupp asymmetry is δ = lx – ly = 737 mm
  - Without constraints from quad damping struts
  - Assuming current envelopes for assemblies (some rather conceptual)

	n, k	$\frac{L_{MC}}{L_{RC}} = \frac{n}{k+1/2}$	Lmc	Lprc	Lsrc	Larm
Non-Folded	1,0	2	16681	8341	8327	3995200
Folded	3,2	1.2	15840	13200		3995200

N.B.:

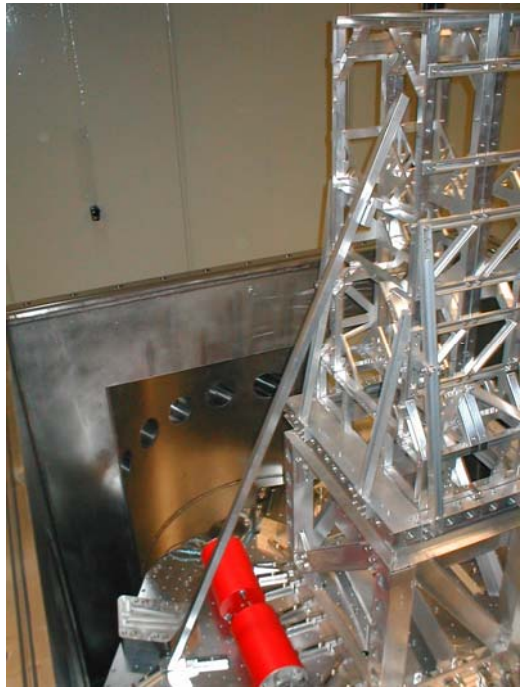
1) A single stage HAM isolation system (currently under study) would allow for a lower height HAM optics table. This would permit more freedom in locating the triple suspensiuons (MC & RCs) and change COC wedge angles.

2) Modulation frequencies and cavity lengths will not be fixed until the ISC CDR planned for Oct '06. In the meantime the layout efforts should define physical limits to the cavity lengths for various options.



Tight Fit for ITM Chambers

- Damping struts for the quad structure
  - Concept tested at the ETF to damp 1st bending modes of SUS structure & reduce SEI/SUS coupling
  - Not clear that there is enough room for one in each of the x and y directions (principal bending axes) for ITMx or for the ETMs (with a large beam reducting telescope behind the RM)



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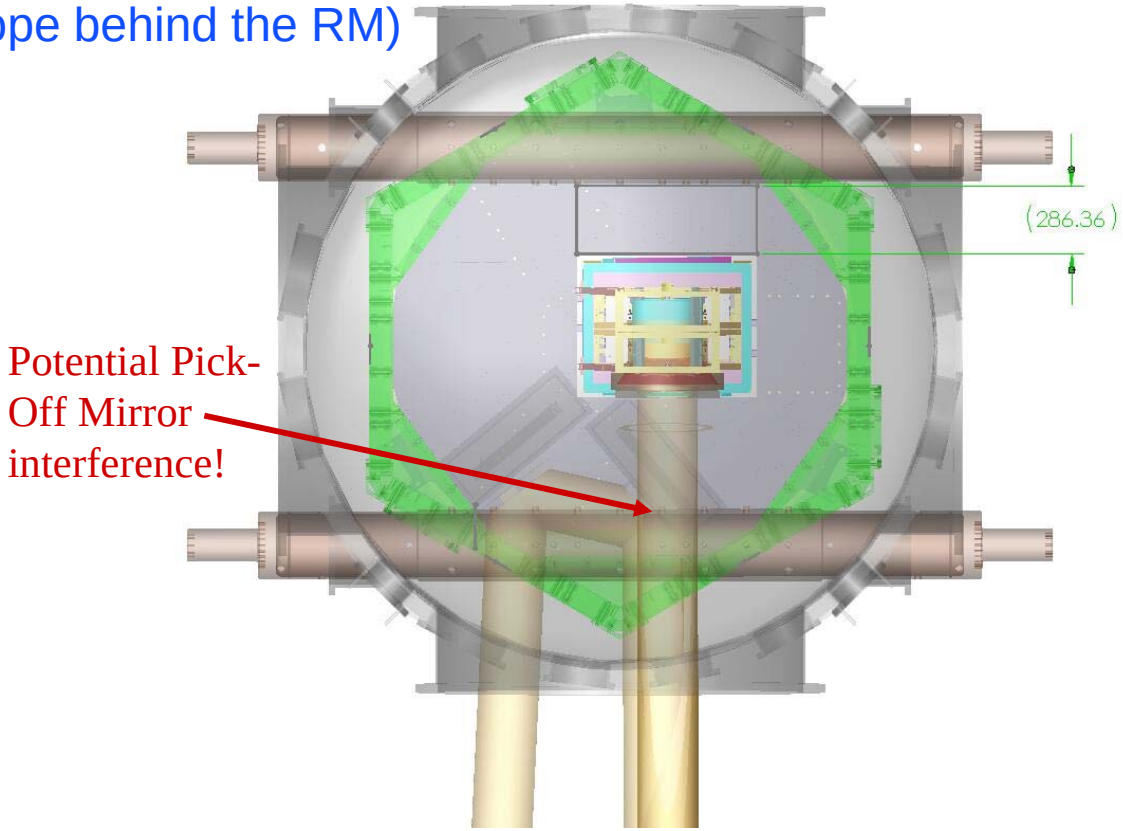
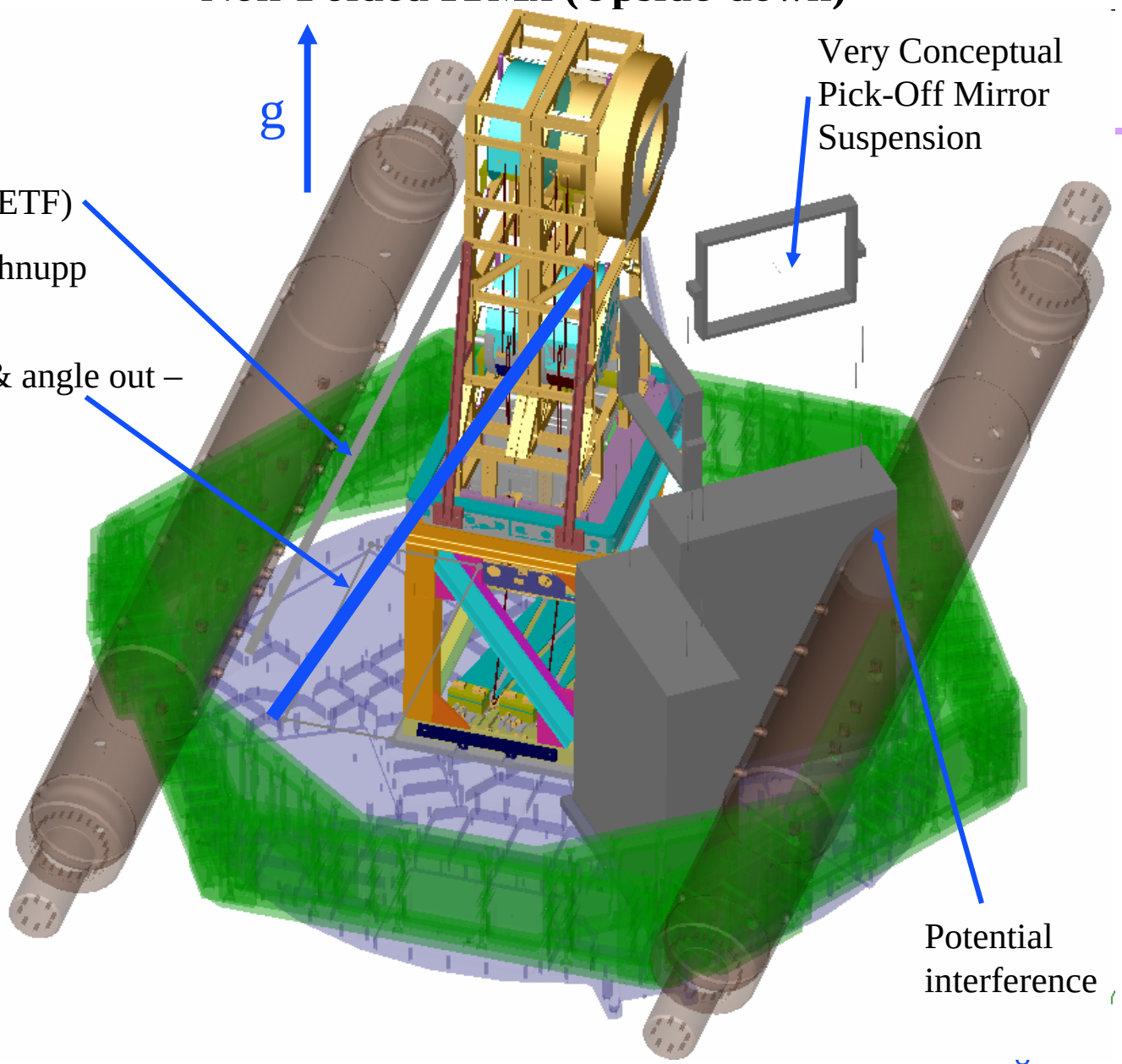


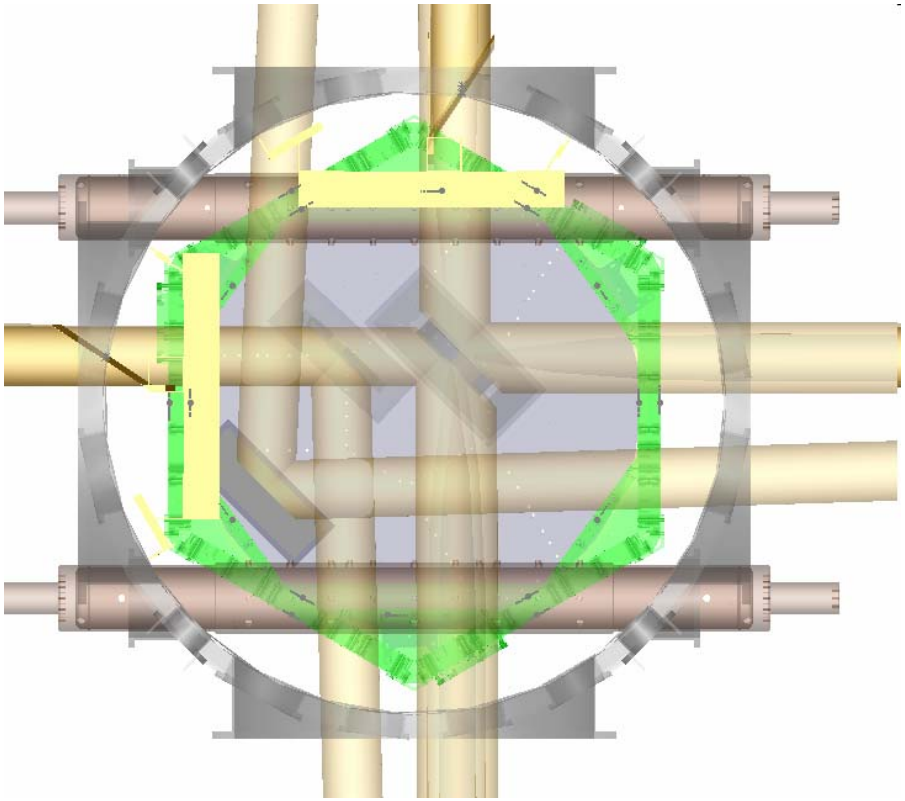
ITMy Chamber Layout as viewed from below

Non-Folded ITMx (Upside-down)

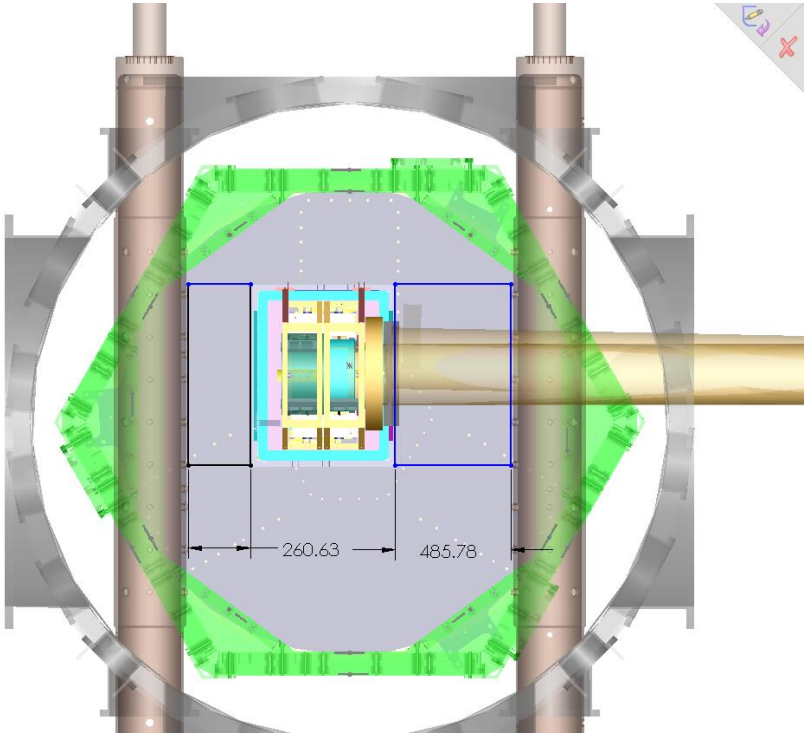
- 1.62m damping strut (ala ETF)
  - As shown Limits Schnupp Asymmetry
  - Can attach to front & angle out – also other direction



Tight Fit for ITM Chambers (continued)



Nonfolded BS Chamber Layout
as viewed from below



Nonfolded IFO, ITMx Chamber Layout
as viewed from below

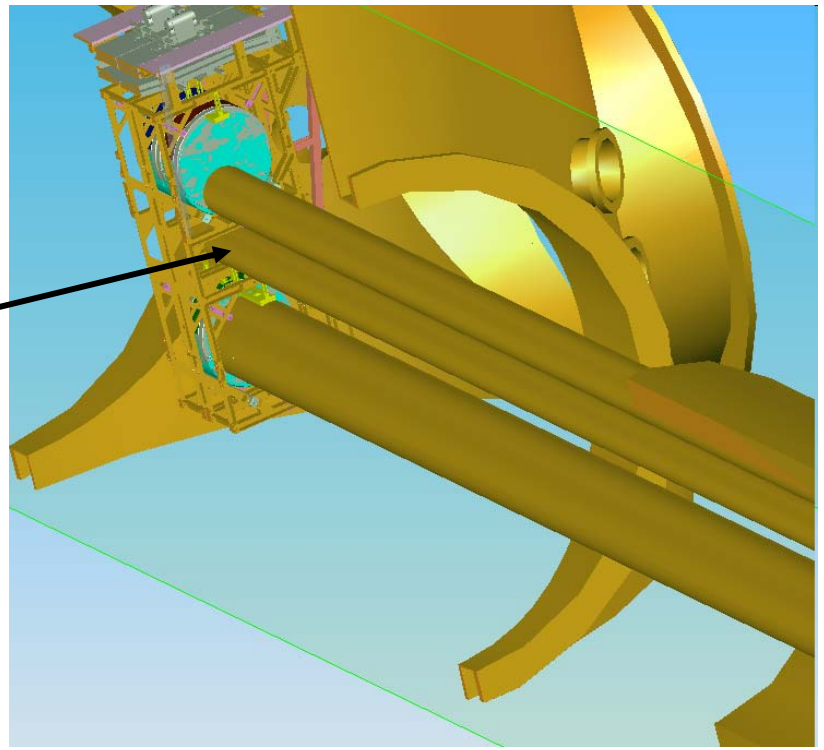
Stable Recycling Cavities Evaluation Plan

- a) define a workable layout
  - To be completed by early April to decide on VE & SEI infrastructure for baseline costs
- b) Phil determines implications for thermal compensation
- c) Guido determines ASC matrix and implications
- d) Hiro develops FFT model to handle analysis of ROC tolerance, angular stability, etc.
- e) Hiro & Phil et. al. apply FFT model to determine if stable & nearly degenerate PRC work
  - To be completed ~Aug, 2006

SPI

- SPI (Suspension/Seismic Point Interferometer)
- RODA to define interface for attachment of retroreflector or piezo-actuated mirror to the SUS quad structure at a height between the TM and PM
- Being included in cost baseline, though not yet formally part of the technical baseline

Proposed SPI beam location
(150 mm diameter)



Further Work

http://www.ligo.caltech.edu/~coyne/AL/SYS/default.htm

- Near-term:
  - Complete credible baseline & stable RC layouts for folded & un-folded (using current assembly envelopes)
  - Decide if 5 HAM-SEI systems suffice
  - Revise the optical layout document
- Further–term:
  - Layouts suffer from guessed envelopes for a number of assemblies – need to develop better definition
    - Pick-Off Mirrors, BS SUS, FM/ITM SUS, etc.
  - Complete PDMWorks “infrastructure” (common chamber models, common 3D envelope models, etc.)