



Adv. LIGO LSC Scheme for the 40m

Kirk McKenzie, for the 40m Team

LSC meeting, March 2007



Talk Contents

- Current 40m LSC scheme.
- Goal of the new LSC scheme
- Constraints/tunable parameters
- Suggested layout
- Noise budget
- Parameters / implications
- issues



The current LSC scheme at 40m

- Designed with the first incarnation of the Adv. LIGO LSC in mind
 - Large Schnupp Asymmetry to couple sidebands to the dark port.
- High modulation frequencies - $f_1 = 33\text{MHz}$, $f_2 = 166\text{MHz}$.
 - Too high - difficult to design electronics
 - Too different from iLIGO, can't use the same electronics
- Undercoupled Power recycling cavity, unlike LIGO and Adv. LIGO
 - Due to anomalous loss, also seen in iLIGO
 - Different optical response
 - Changes signals for lock acquisition

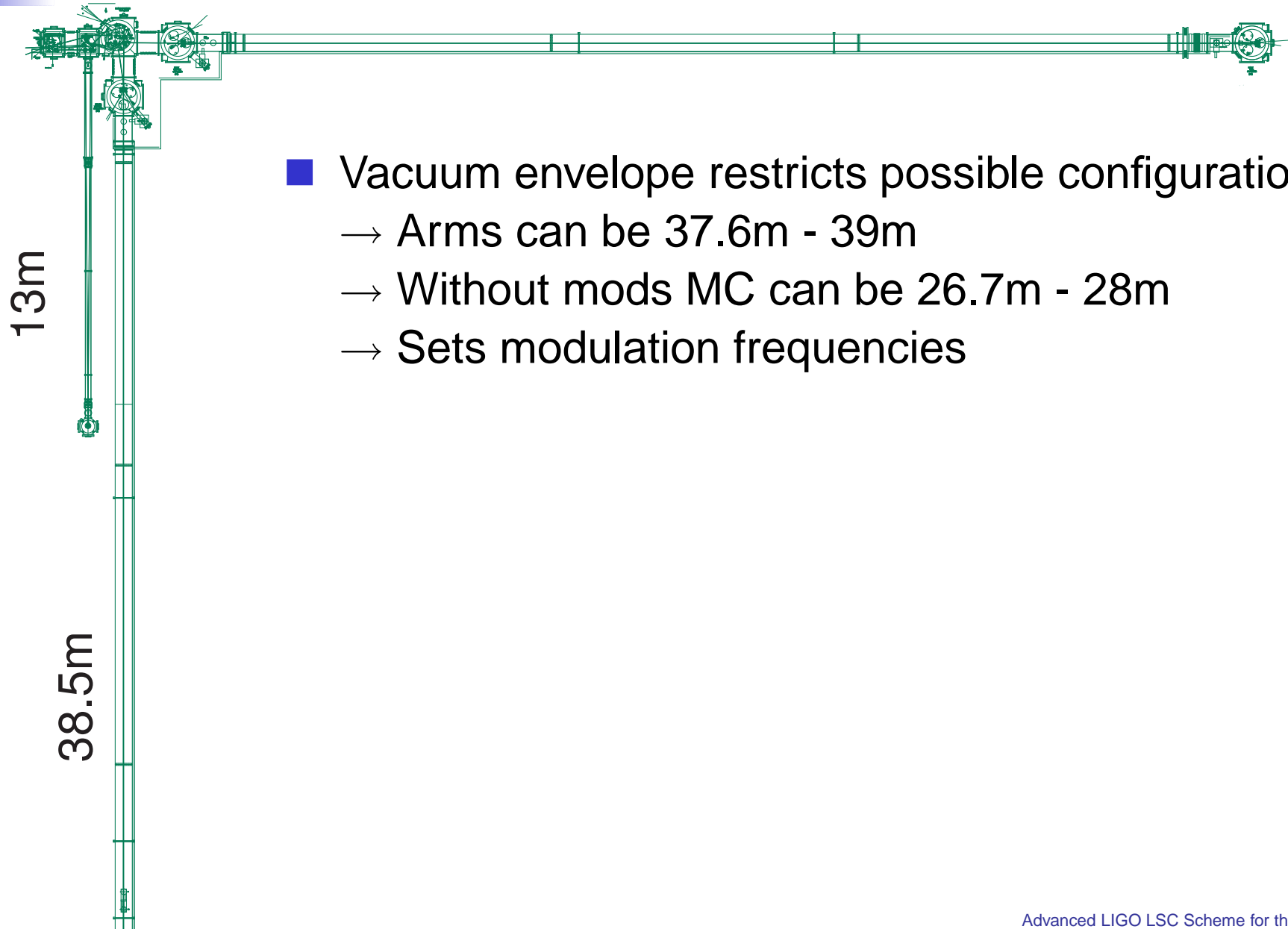
Goals of a new LSC design at the 40m

- Test Adv. LIGO control scheme
 - Conceptually fairly different to current, imperative to test
 - Continuously tuneable signal recycling cavity (SRC)
 - Lock acquisition.
- Test system with intra-cavity optics for PRC and SRC

Reflectivities, as seen by $f2$

SRM	Mich	PRM	
(□)	
93%	0%	93%	40m now
(□)	
93%	99%	93%	40m new

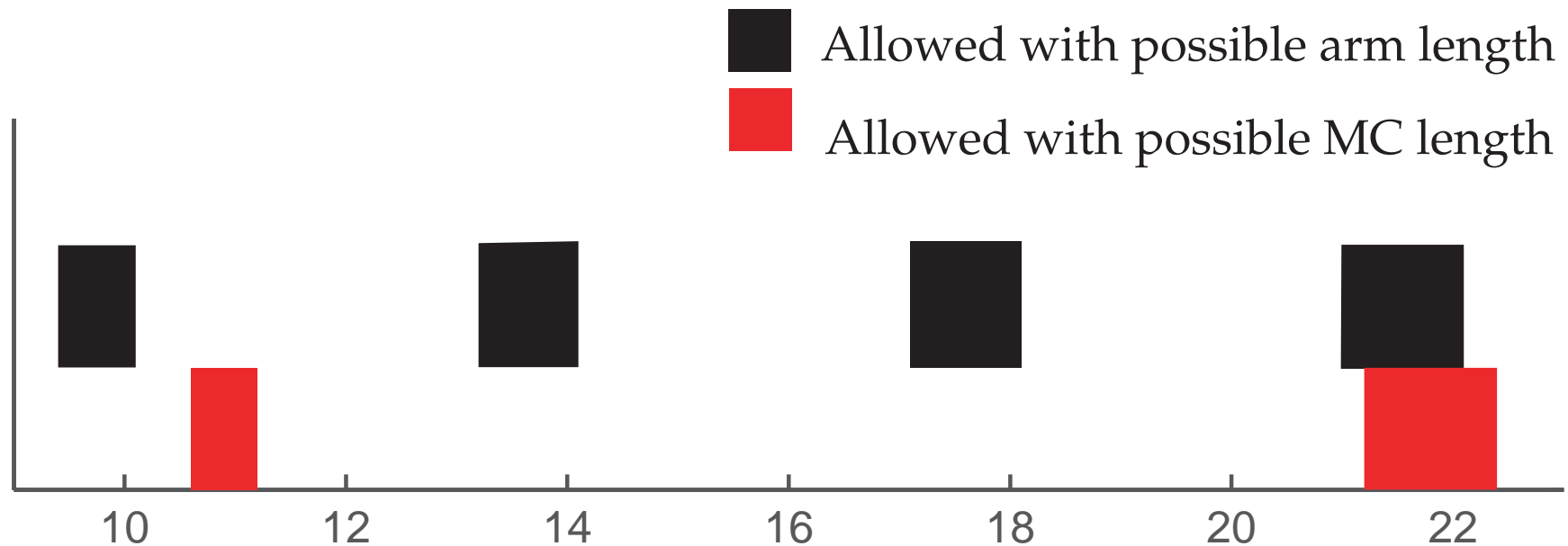
Vacuum Envelope



- Vacuum envelope restricts possible configurations
 - Arms can be 37.6m - 39m
 - Without mods MC can be 26.7m - 28m
 - Sets modulation frequencies

Selection of Modulation Frequencies

Allowed Modulation frequencies



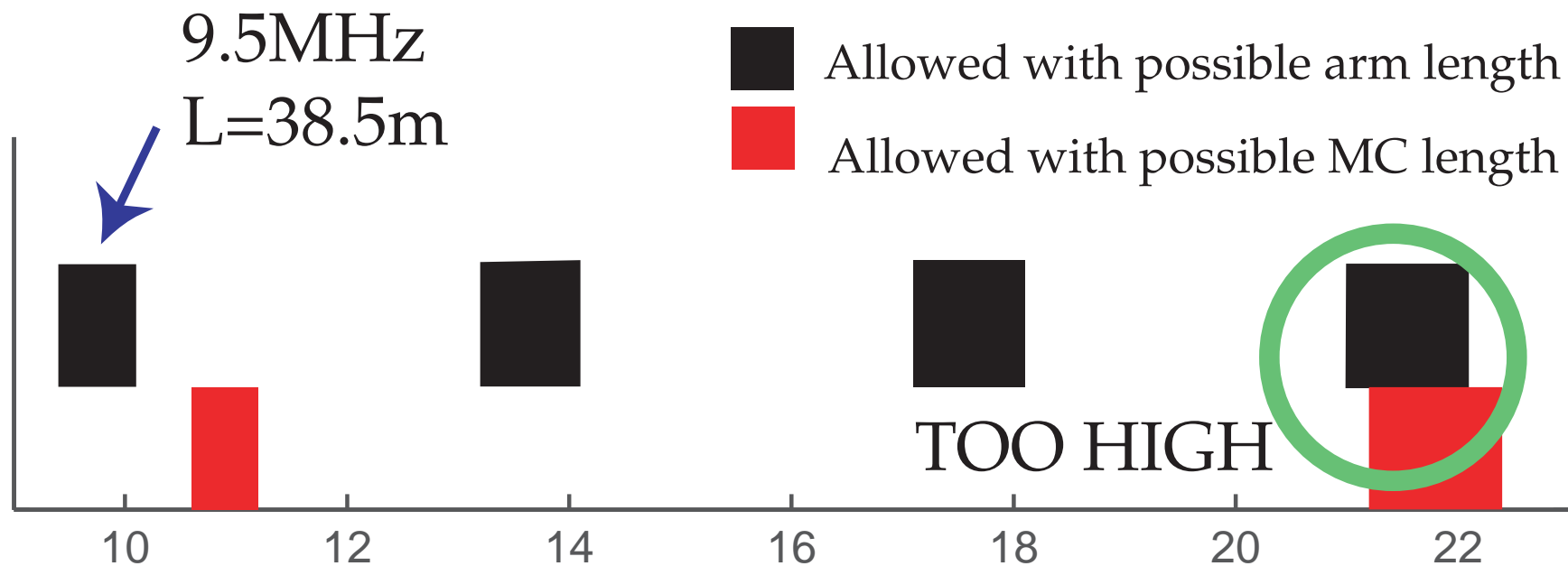
Lower Modulation frequency, f_1 (MHz)

$$\text{FSR of MC} - f_{mc} = \frac{c}{2L_{mc}}$$

$$\text{Anti-resonant in arms } f_1 = \left(n + \frac{1}{2}\right) \frac{c}{2L}$$

Selection of Modulation Frequencies

Allowed Modulation frequencies



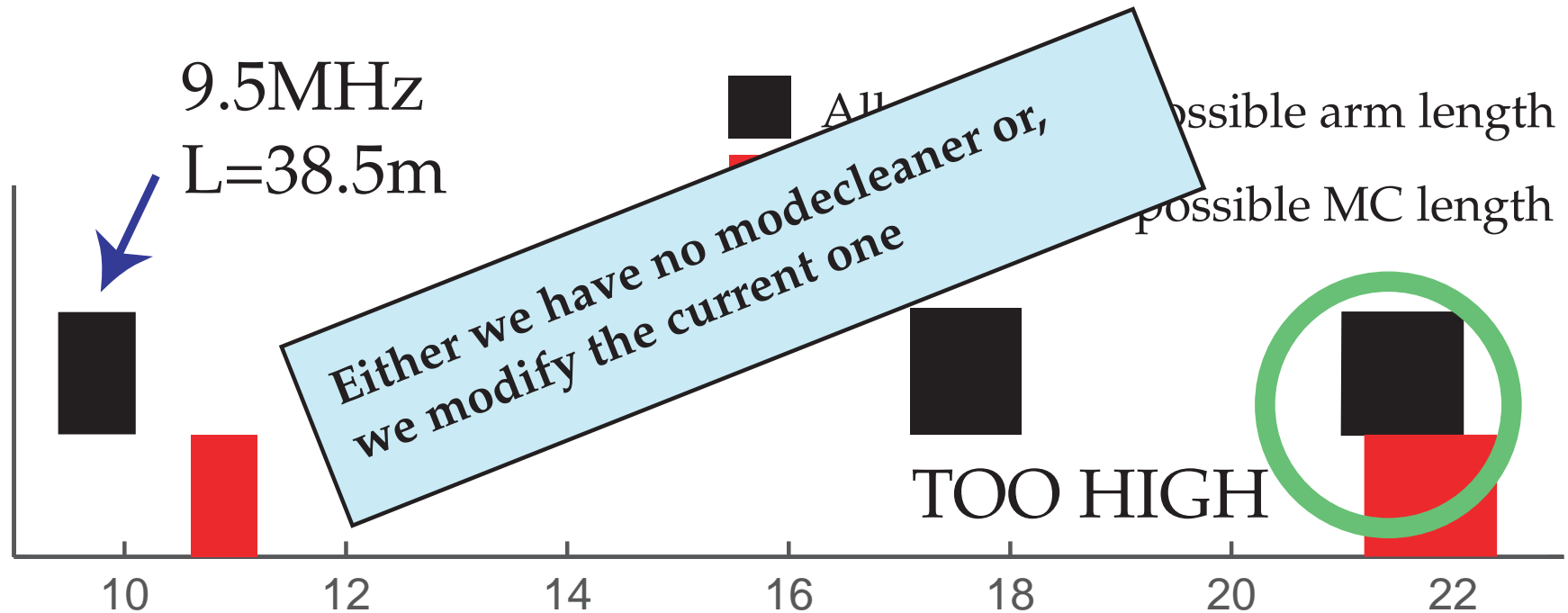
Lower Modulation frequency, f_1 (MHz)

$$\text{FSR of MC} - f_{mc} = \frac{c}{2L_{mc}}$$

$$\text{Anti-resonant in arms } f_1 = \left(n + \frac{1}{2}\right) \frac{c}{2L}$$

Selection of Modulation Frequencies

Allowed Modulation frequencies



FSR of MC - $f_{mc} = \frac{c}{2L_{mc}}$

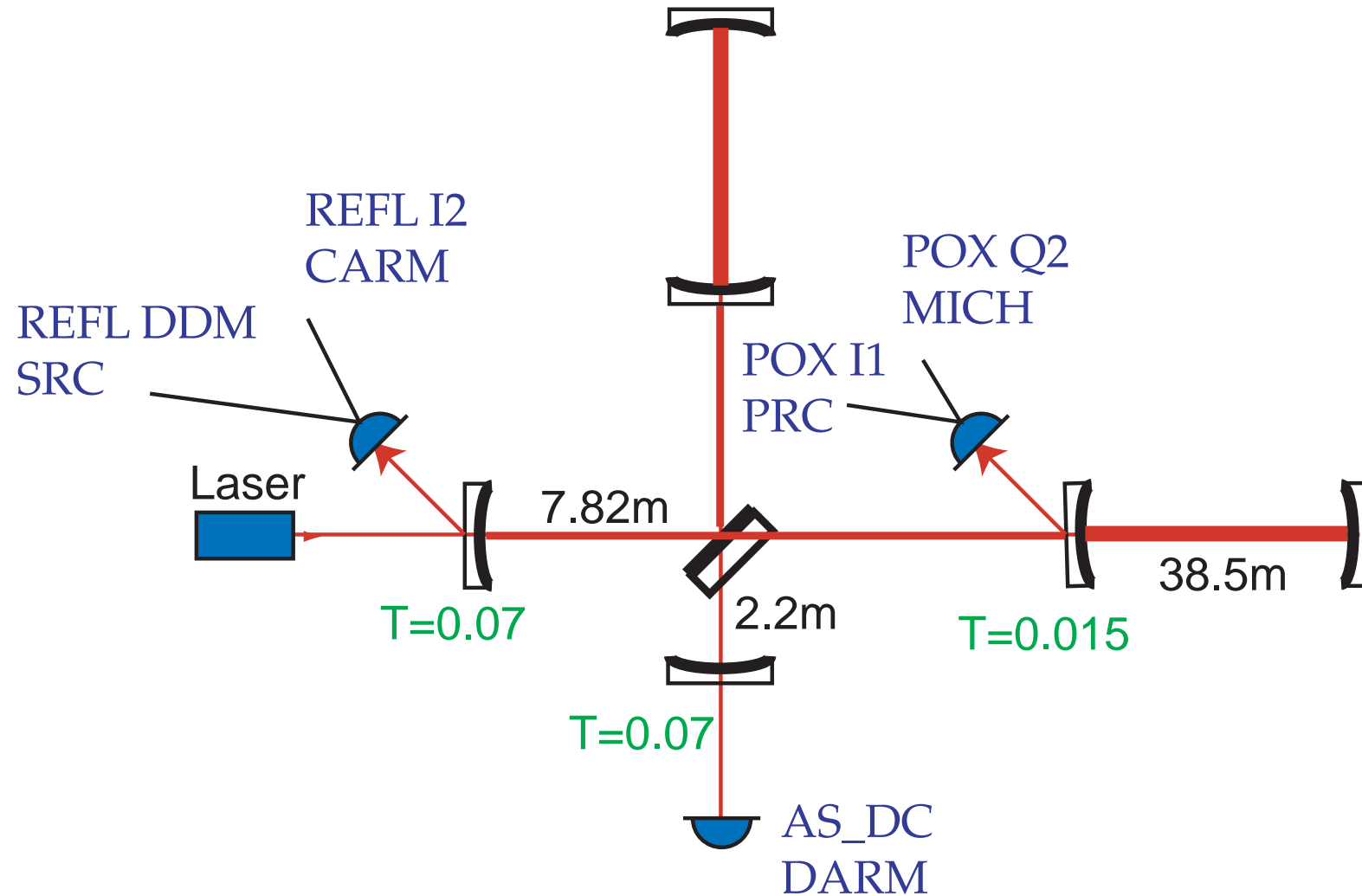
Anti-resonant in arms $f_1 = (n + \frac{1}{2}) \frac{c}{2L}$



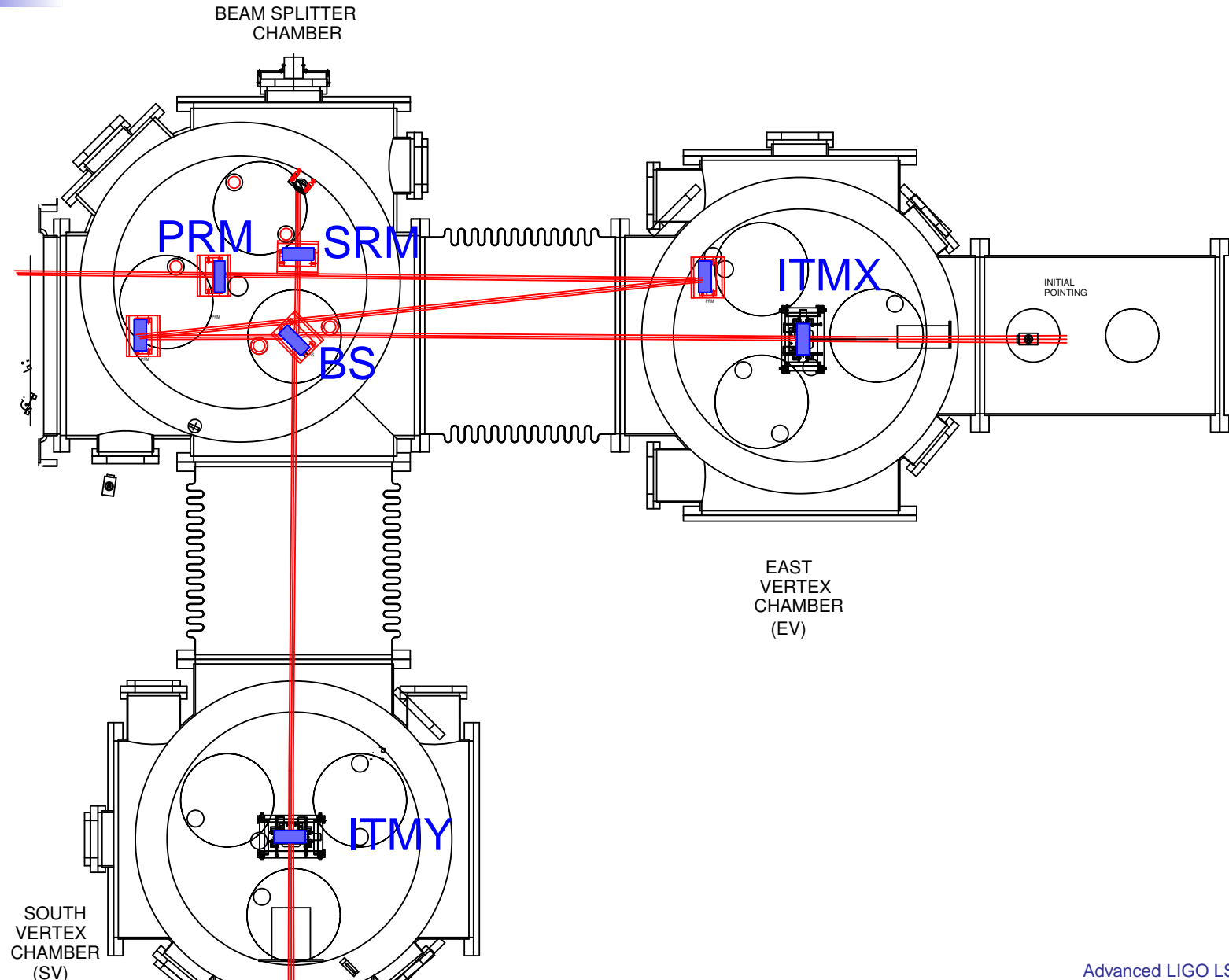
Some parameters

	Adv. LIGO	40m Now	40m New	units
L	3995	38.5	38.5	m
f_1	9.0	33.1	9.5	MHz
f_2	45.1	166.5	47.8	MHz
Δl	0.12	0.45	0.10	m
l_{PRC}	58.14	2.26	7.82	m
l_{SRC}	56.54	2.16	2.21	m
γ	0.2 / 0.8	0.3	0.5	
P_{in}	125 / 7	1	3	W
T_{itm}	0.005	0.005	0.015	

Layout and signals

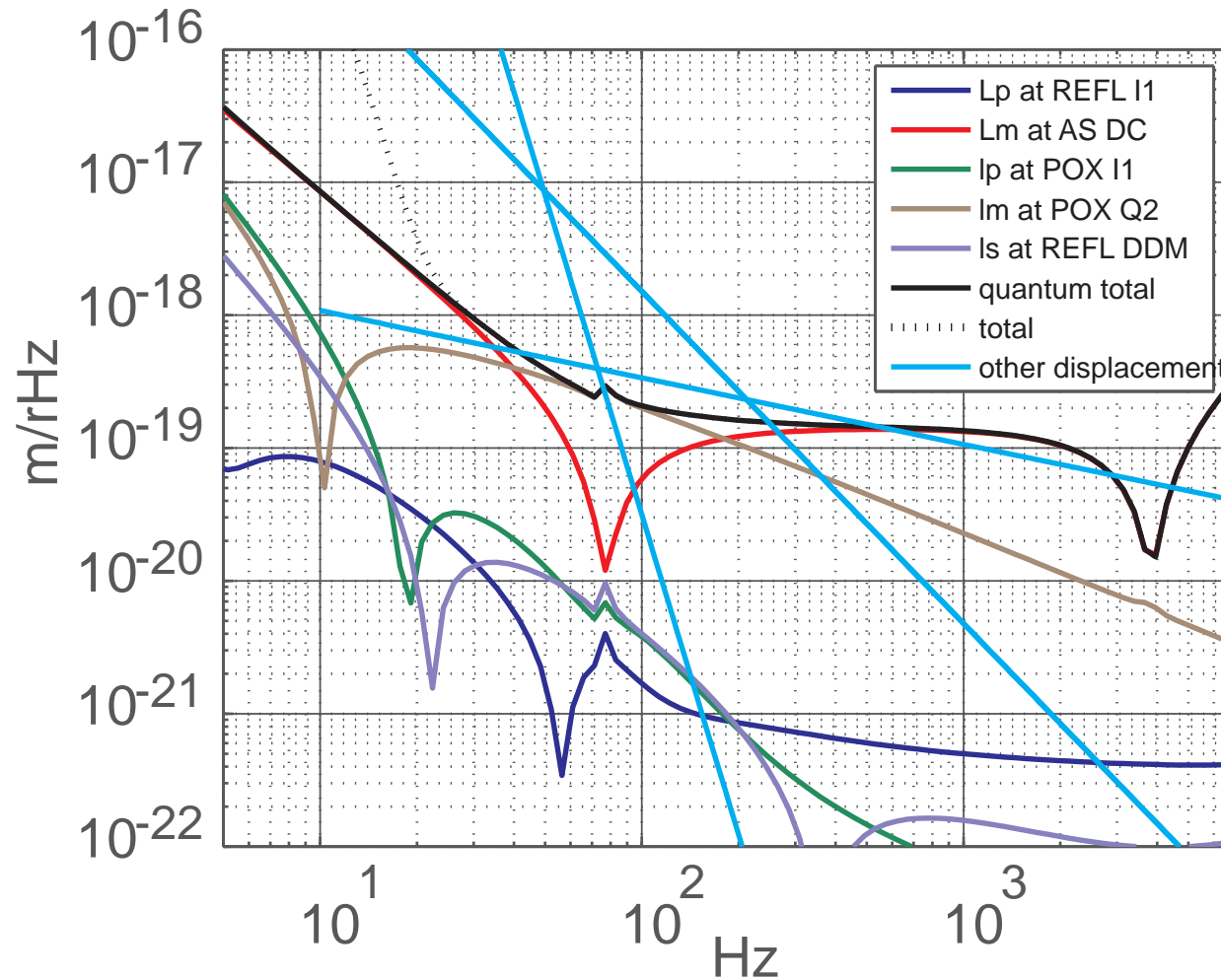


Layout of PRC and SRC



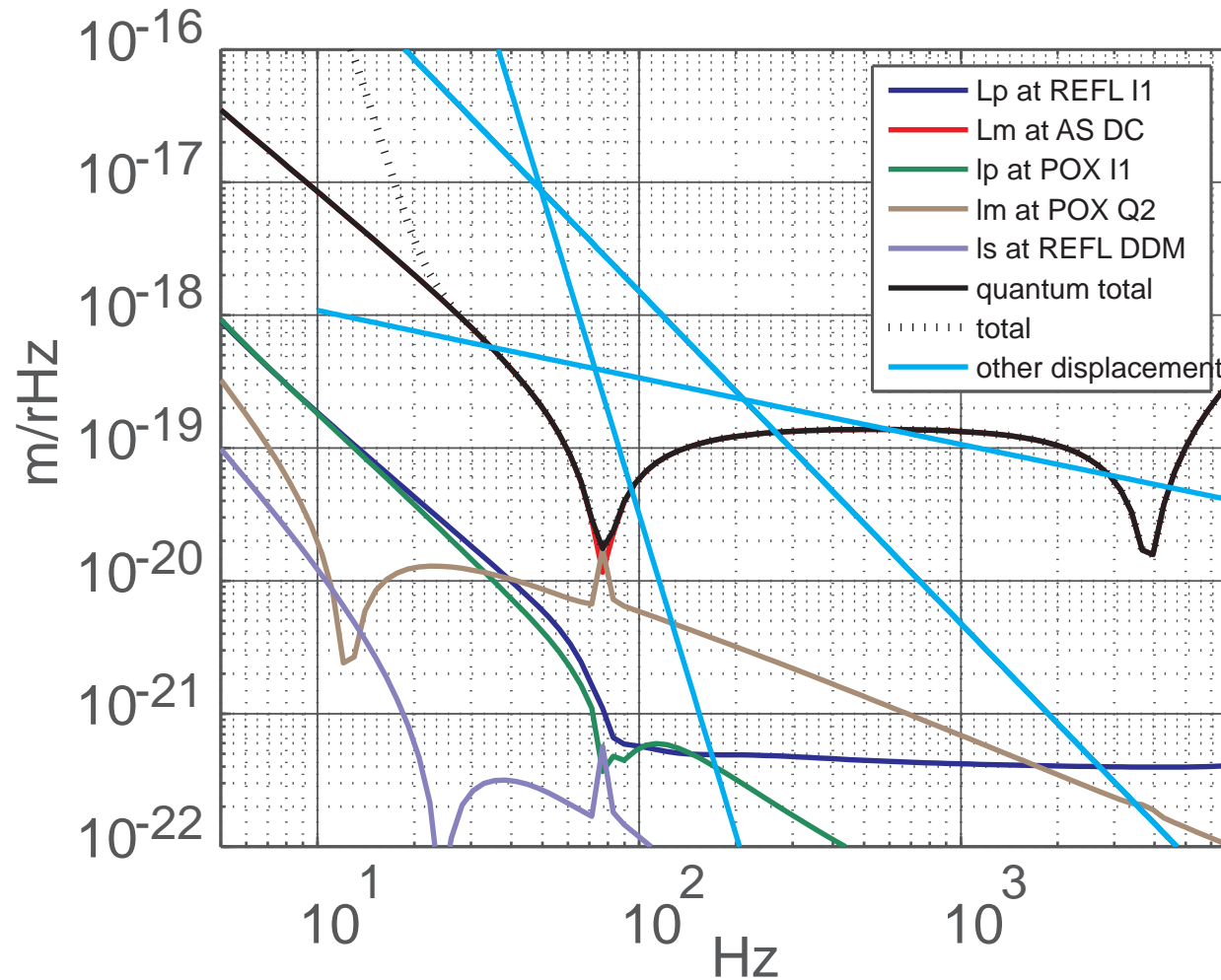
Noise Budget

Signal to noise with Isc coupling - no feed forward



Noise Budget

Signal to noise with Isc coupling with feed forward





Some issues

- Detuning of optical resonance: (currently 1-5kHz seems ok)
- Lock acquisition
- Mode-matching intracavity
- Do we suspend folding mirrors in the PRM
- Error signals with offsets
- Other things?



Last Slide

- Adv LIGO LSC is still evolving
- More work needs to be done in this design
- Looks like Adv LIGO LSC can be implemented at the 40m