Multiple Paths to Stabilize Collisions

1. Quiet Site + Engineered Detector.
2. Active Stabilization of Final Doublet.
3. Intratrain Feedback (FONT/Feather).

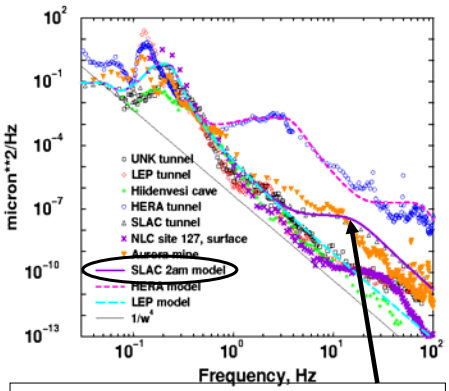
Luminosity is > 90% if any two out of three are used, > 66% if only one approach is used.
Measurement-based result (average): 90%.

Detector Noise	Stabilization	FONT	LINAC/BDS Jitter	Luminosity (%)
20nm**	No	No	Nominal	30
NLCTA average*	Meas*	No	Nominal	59
4nm	No	No	Nominal	66
NLCTA quiet*	Meas*	No	Nominal	69
20nm**	Ideal	No	Double	78
20nm**	No	Ideal	Nominal	81
20nm**	Ideal	No	Nominal	90
NLCTA average*	**Meas***	**Meas***	Nominal	90
4nm	Ideal	No	Nominal	91
NLCTA quiet*	Meas*	Meas*	Nominal	92
4nm	No	Ideal	Nominal	95
20nm**	Ideal	Ideal	Double	98
20nm**	Ideal	Ideal	Nominal	99

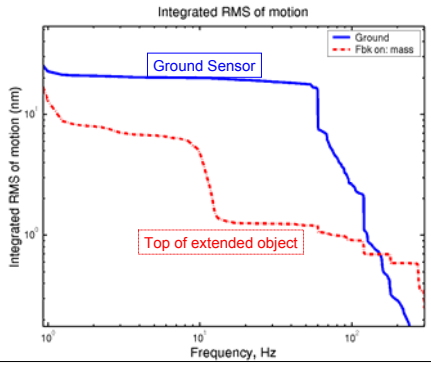
(Luminosity (%): 0 – 100)

*=Based on measured performance.
**=20 nm measured on SLD.

Simulations of various jitter assumptions, for ~2 second timescale. Simulation platform is Matlab+LIAR (tracking)+GuineaPig (luminosity calc).
- 4 imperfect machines are generated with random errors, and 4-5 ground motion seeds are simulated for each assumption, and for each machine.
- All simulations include the SLAC site ground motion model, plus the budgeted component jitter in linac and beam delivery (BDS).
- 120-hz IP feedback keeps the beams in collision from train-train. Intratrain feedback optionally effects the bunches within a train. Linac&BDS intertrain feedback is neglected (slower timescale).
- "Ideal" stabilization of final doublet is modeled on best commercial sensors. 20 nm detector noise is modeled on SLD measurements (not engineered for quiet design).

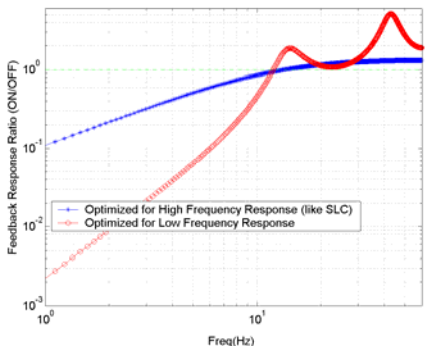


Ground motion models for various sites. SLAC model is used; all proposed NLC sites are quieter. End-station (NLCTA) is noisier.



Measured detector noise and stabilization are from prototype extended object, in NLCTA. Measured motion is used directly in Matlab simulations, with 2 final doublets assumed to be uncorrelated. Cantilevered object design is similar to what could be put into a detector.

Potential for improved measurements:
- *A significant fraction of noise in stabilization measurements is from acoustic sound, which is not expected inside the detector.*
- *Prototype SLAC-built sensor has achieved lower noise than those used in stabilization measurements.*
- *Shorter FONT latency time (ideal) should be achievable.*



120 Hz Feedback Design responses. All simulated feedbacks damp below ~10 Hz. Low frequency design is applied with measured stabilization data.

Intratrain feedback simulations (FONT), with correction within a bunch train. Plots show a response to an 8 nm initial bunch offset, with linear gain optimized for 4.5 nm offset. "Ideal FONT" is based on best achievable latency time estimates (~37 ns). Experiment at NLCTA included additional measured latency due to slower components (total measured latency ~62 ns). Bunch spacing is 1.4 ns. For the average measured stabilization case, ideal FONT gives 94% luminosity, measured FONT gives 90%.