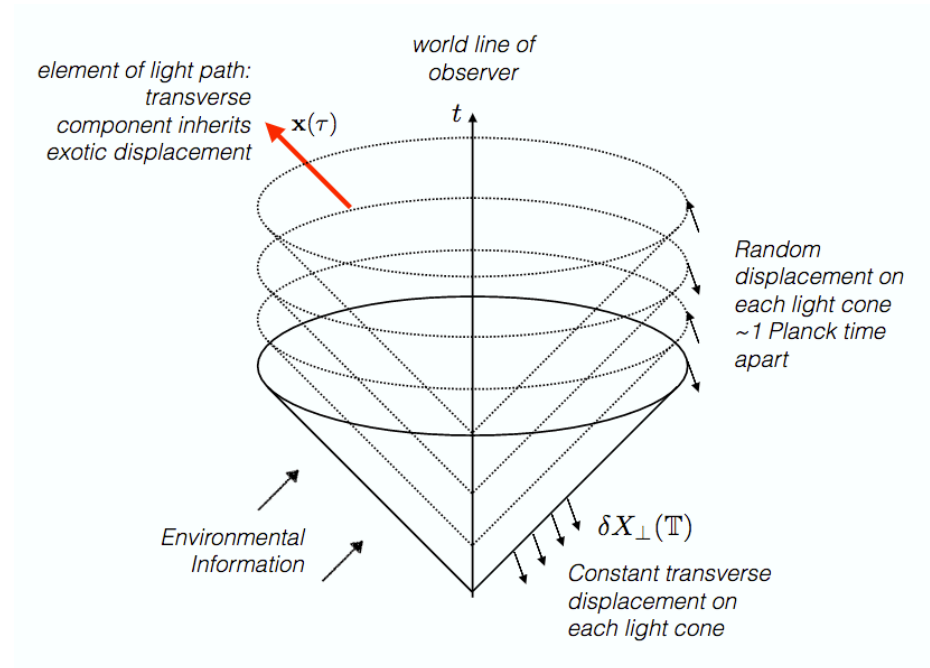
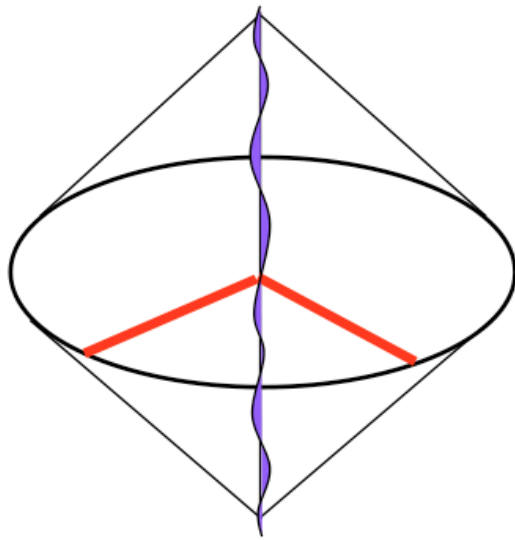


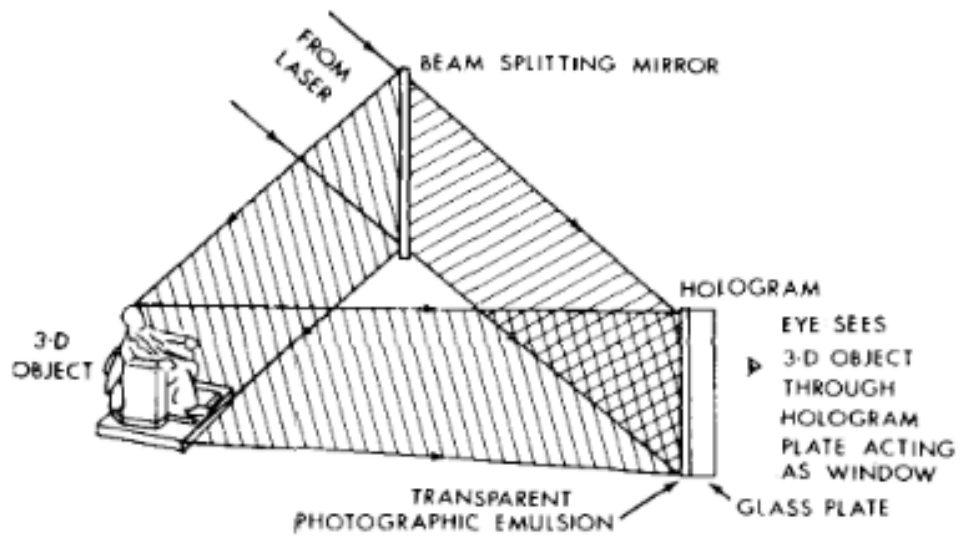
The Holographic Universe with the Fermilab Holometer



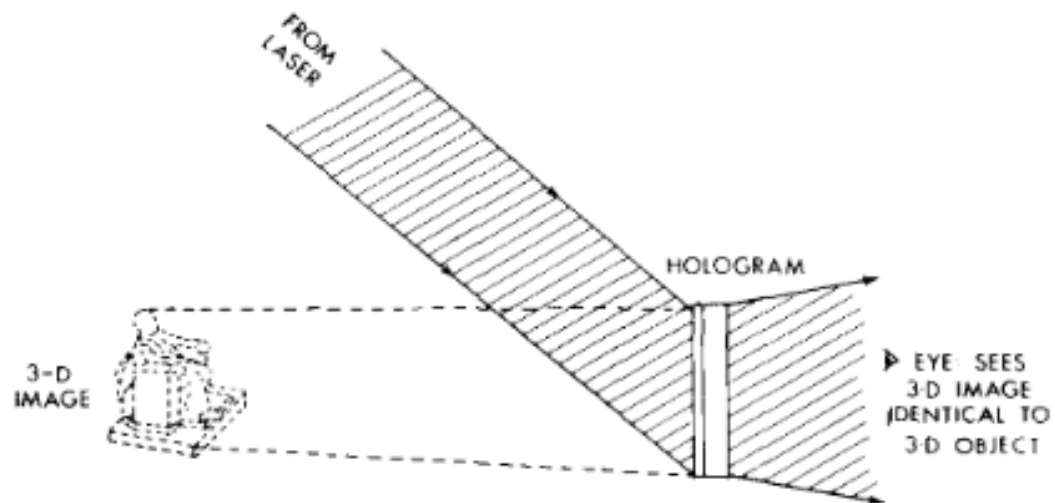
Chris Stoughton (Fermilab)
for the Holometer Collaboration

DOE Laser Safety Officer's Workshop
September 27, 2016

D. Gabor



RECORDING



RECONSTRUCTION

Fig. 10.
3-D Holography of a Diffusing Object with Laser Light.

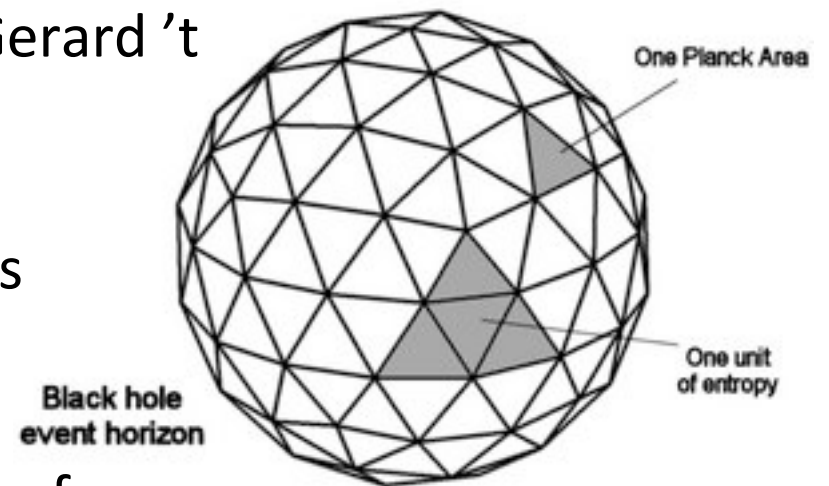
Holographic Principle

“Nature’s book keeping system: the data can be written onto a surface, and the pen with which the data are written has a finite size.” - Gerard 't Hooft

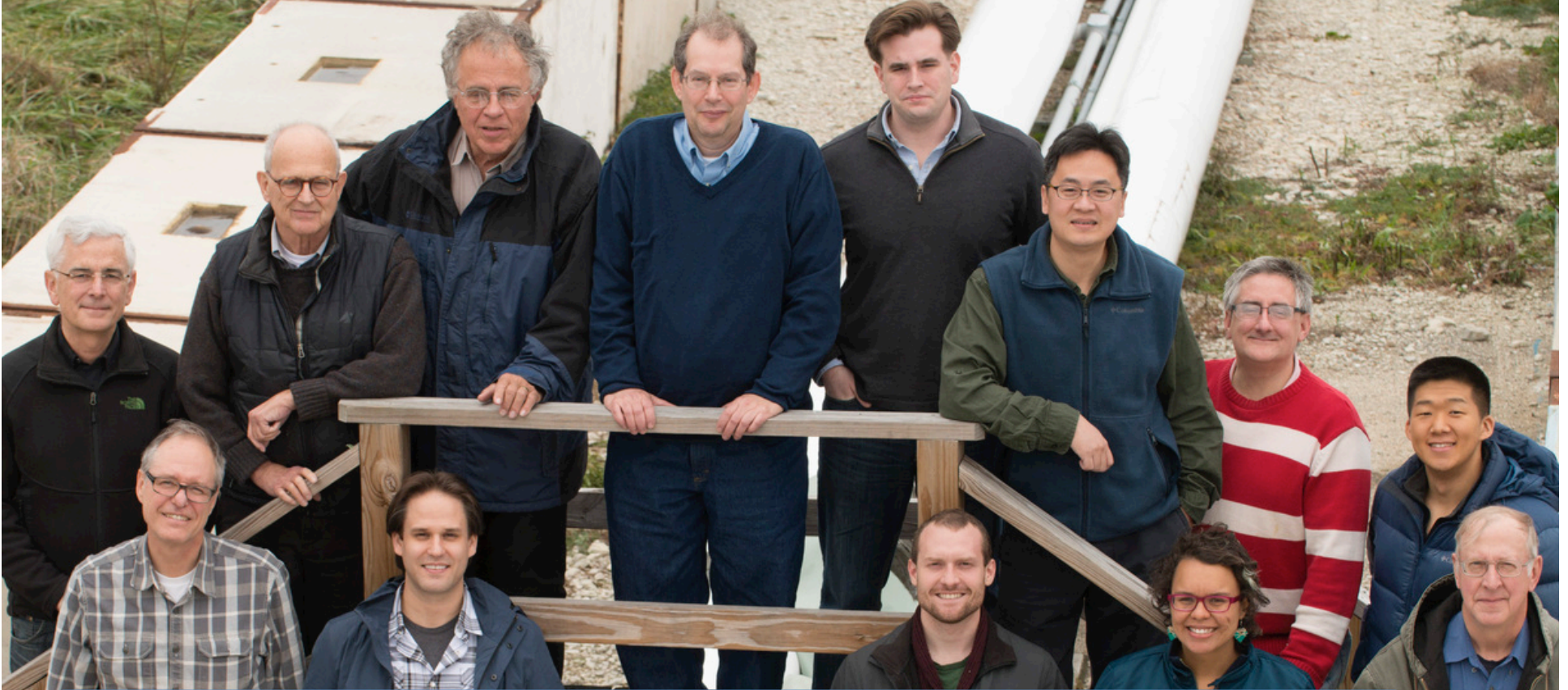
Verlinde calculates the number of states in a sphere: $N_G(R) = 4\pi(R/l_P)^2$.

Treat space-time as a statistical behavior of a quantum system.

States have new forms of spatially nonlocal entanglement.

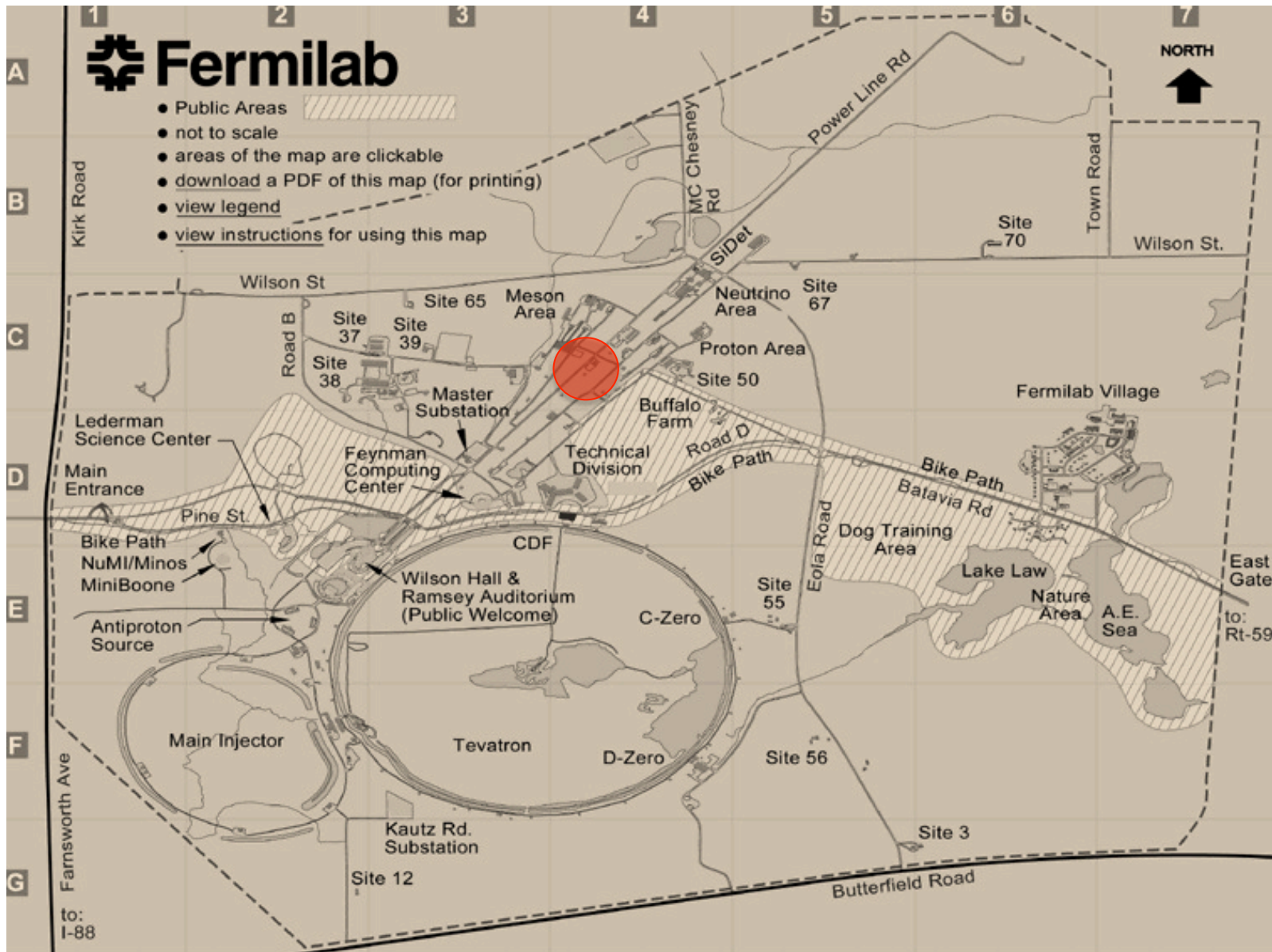


The Fermilab Holometer



- A eight-year \$2.5M project
- Exceeded design specifications on time and budget
- Position measurement to a fraction of the Compton wavelength of the Higgs Boson
- Current reconfiguration: shear $\rightarrow$ rotation

The Fermilab Holometer (E990)



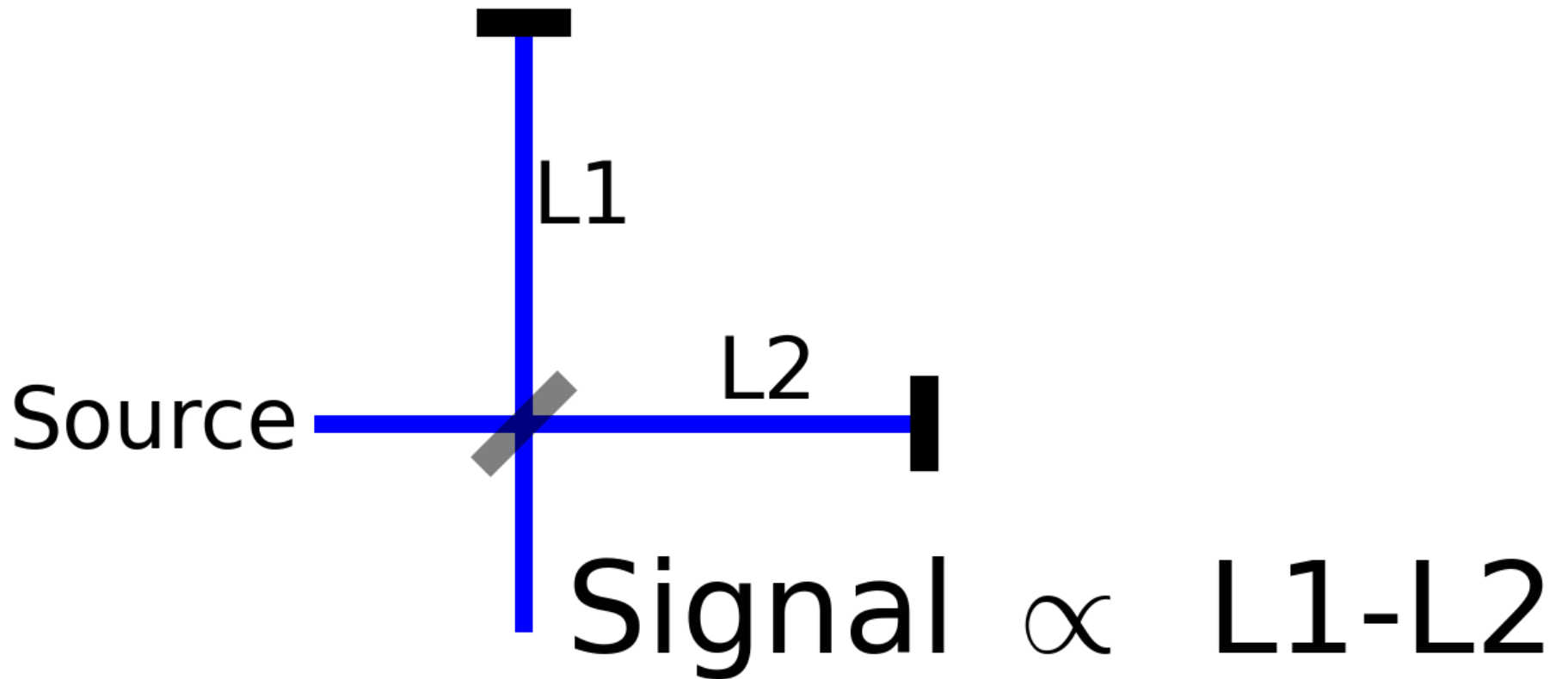
The Fermilab Holometer (E990)



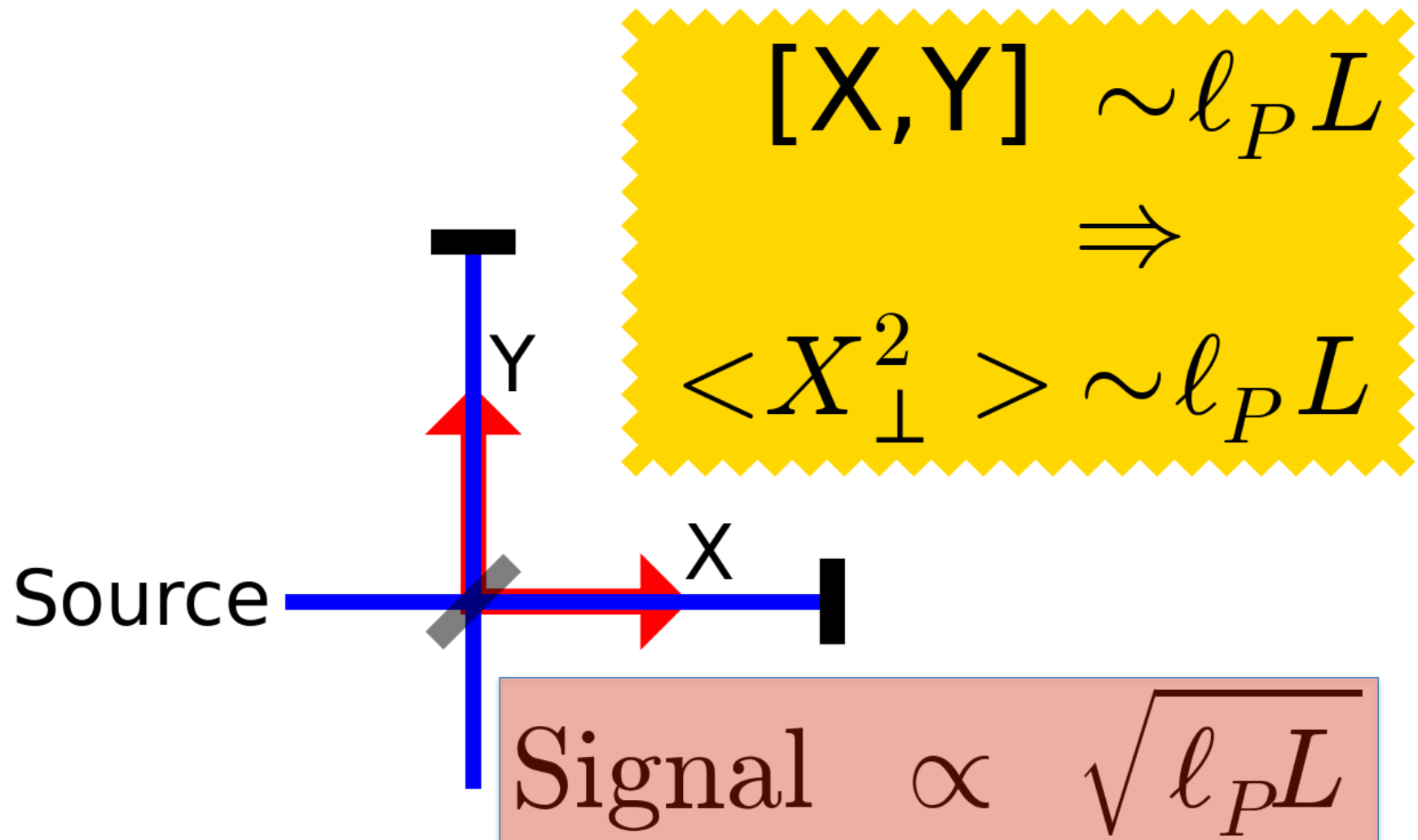
The Fermilab Holometer (E990)



The Fermilab Holometer: One Interferometer



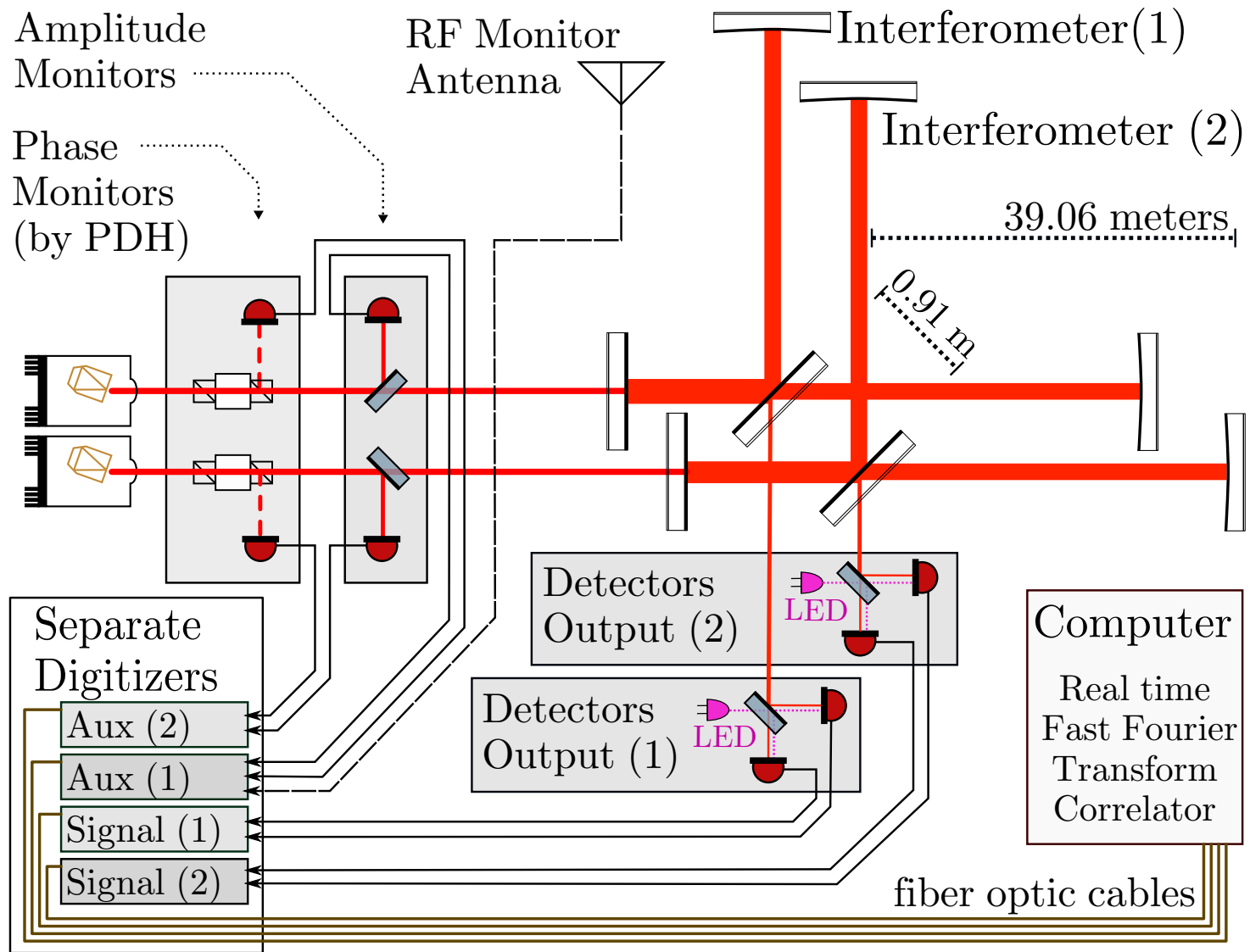
The Planck Scale (and quantum geometry)



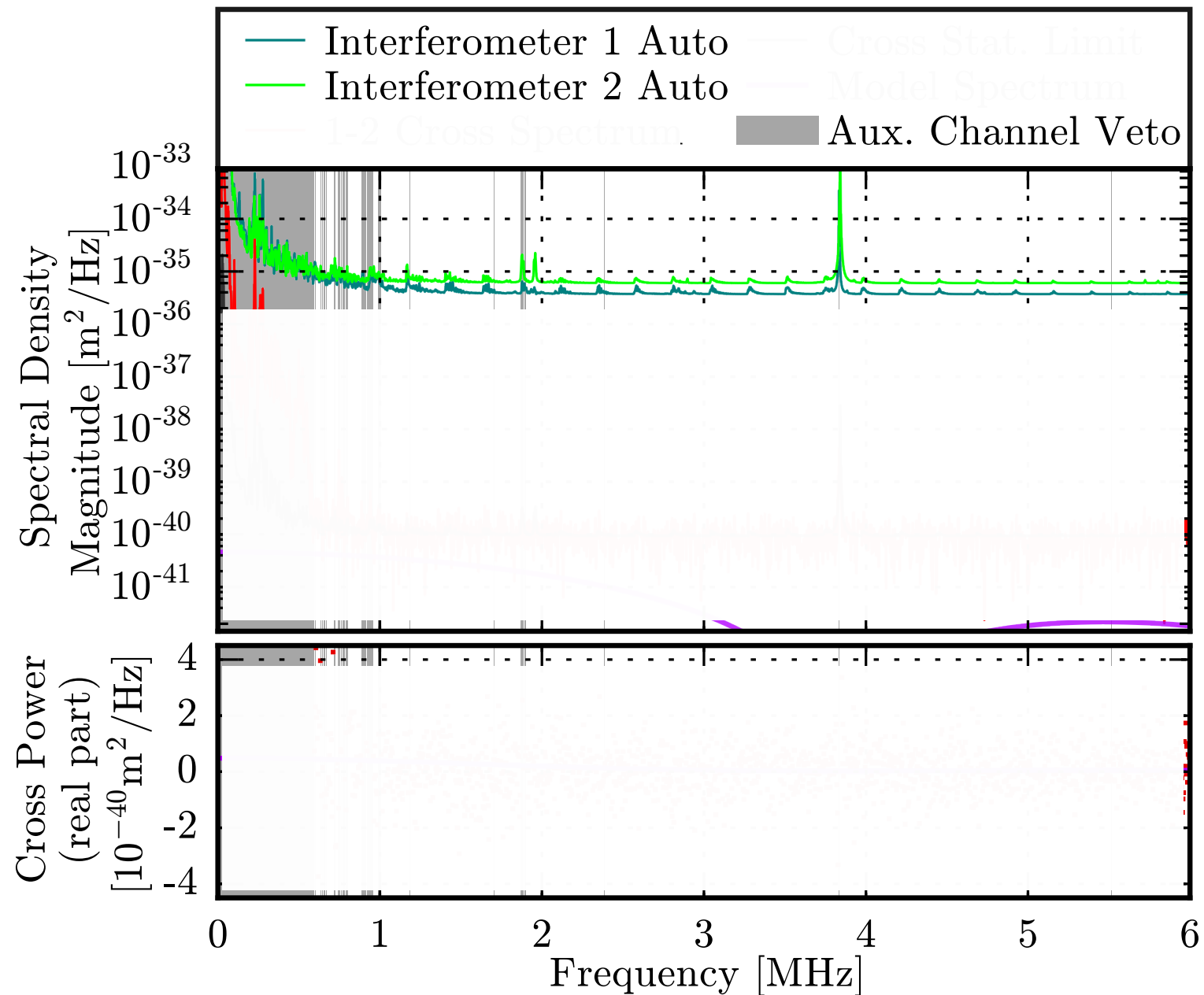
Hogan PR D85 (2012); Hogan+Kwon arXiv:1506.06808 (2015);
Kwon+Hogan (2014); Hogan arXiv:1509.07997

atto = 10^{-18}

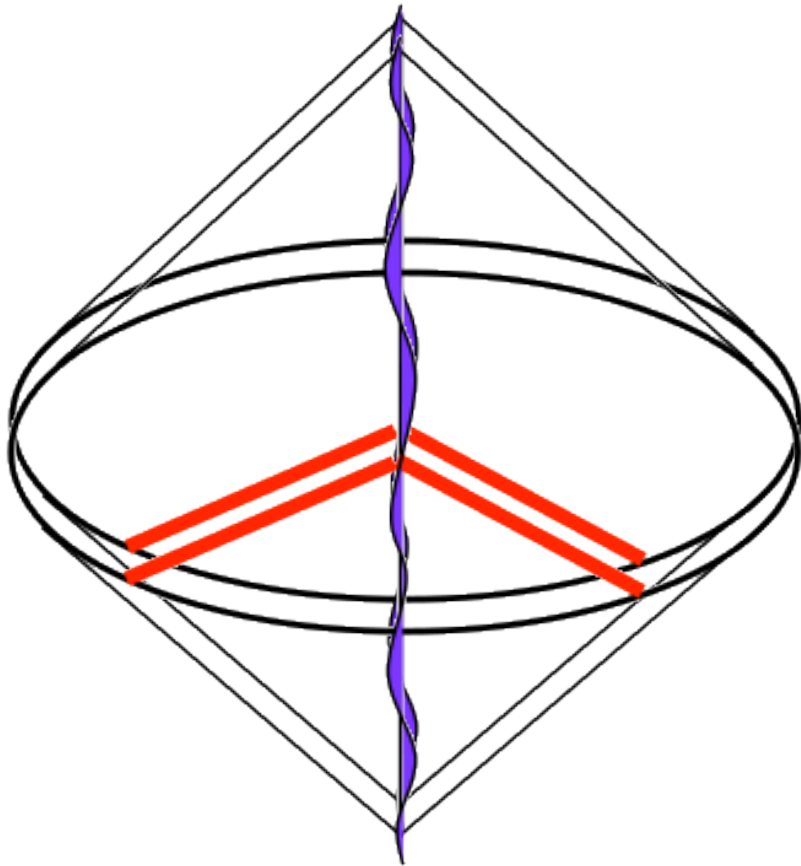
Holometer – Signal Chain



Planck Scale: difficult with 1 IFO

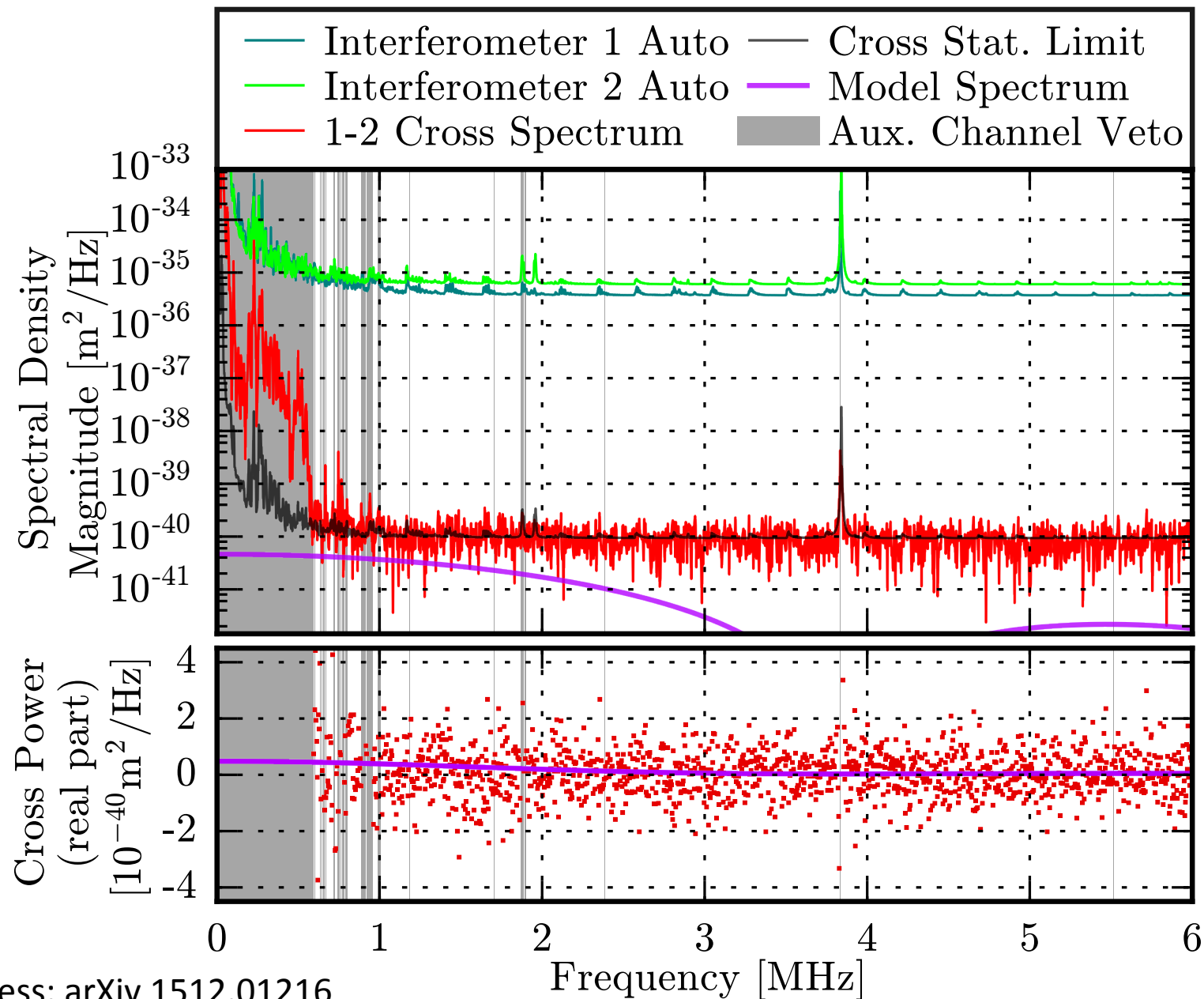


Space-time Correlations

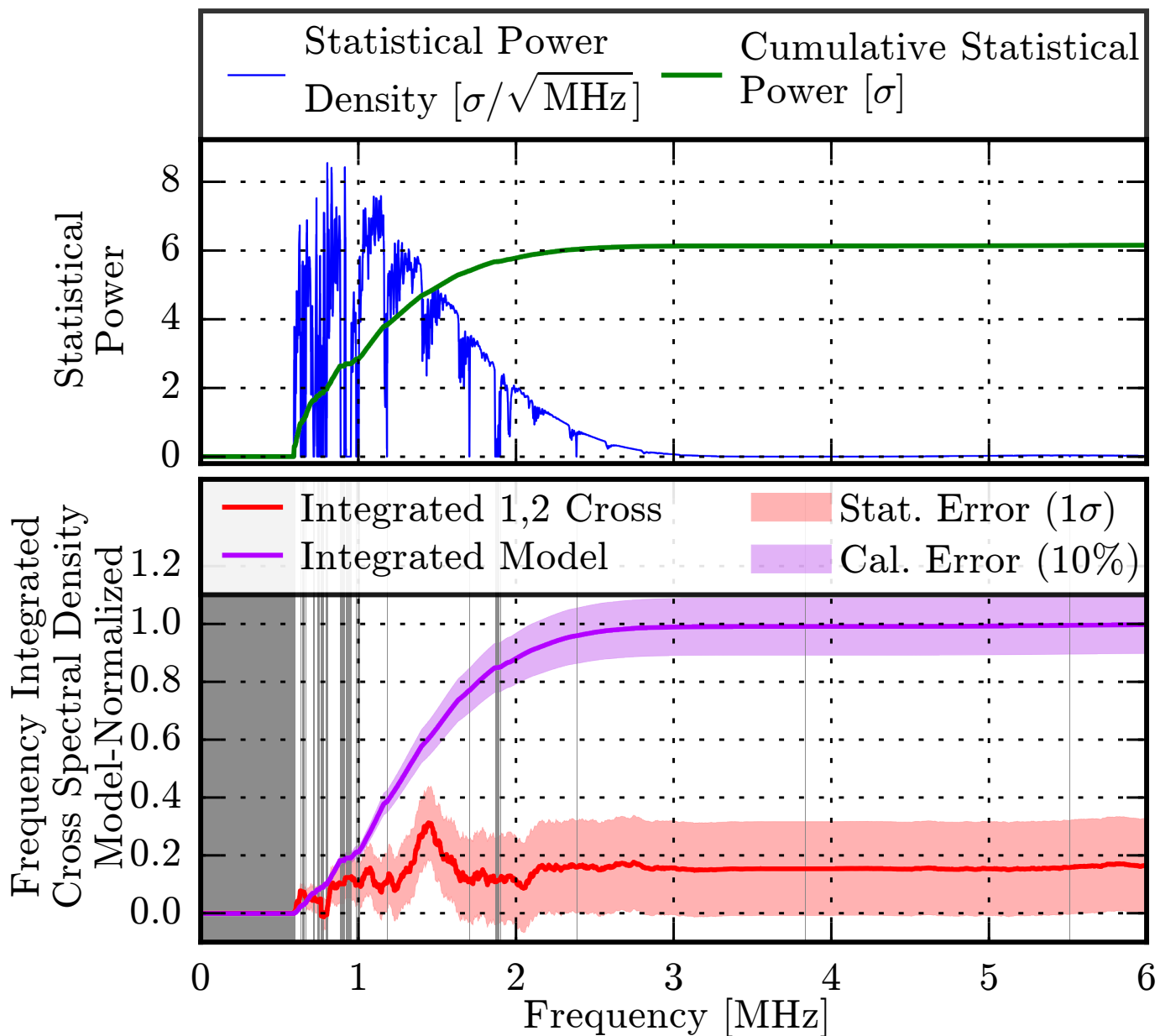


The signals
for two
colocated
interferometers
are correlated

Cross Correlation → Planck Scale

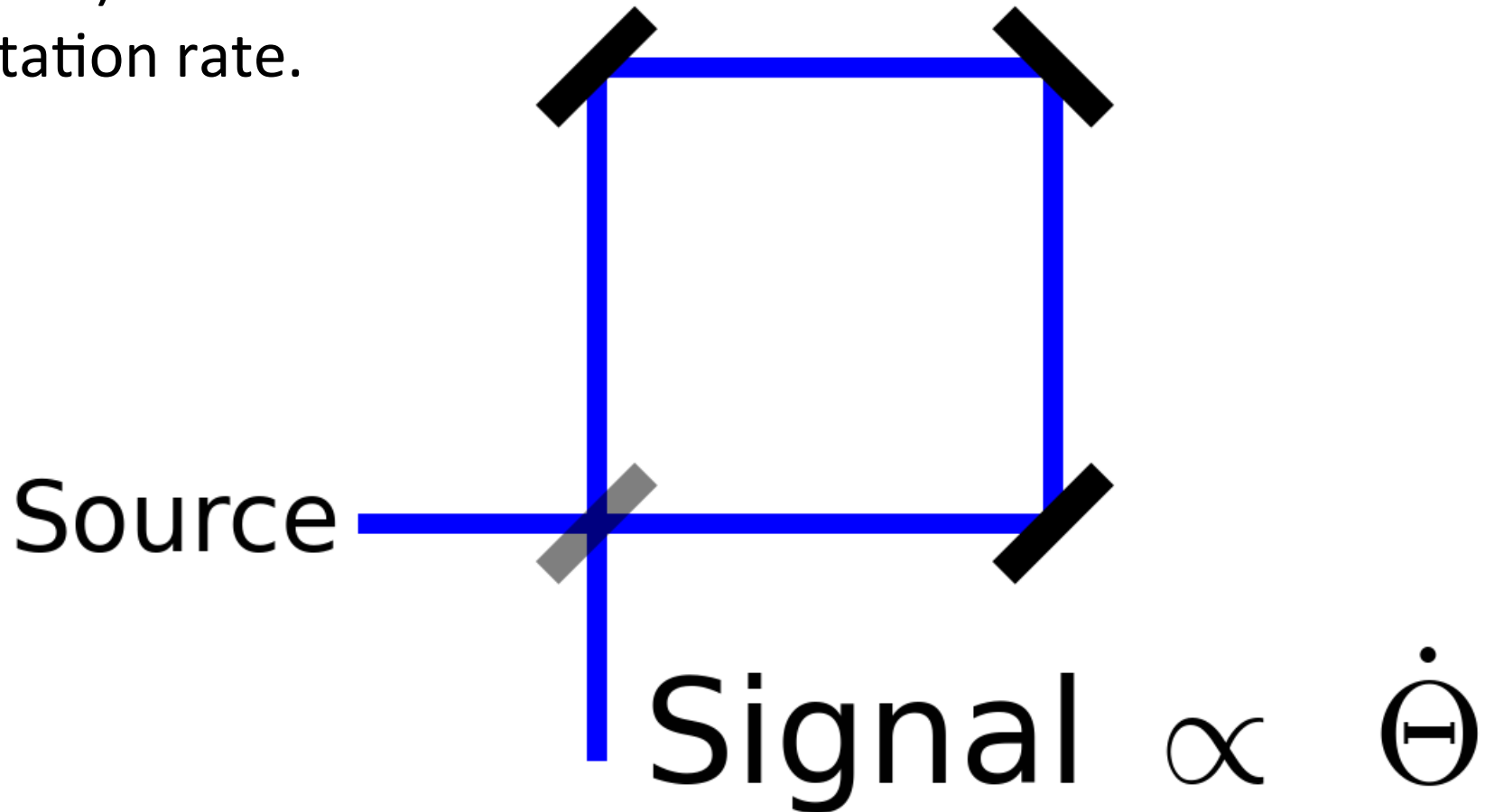


Search Result

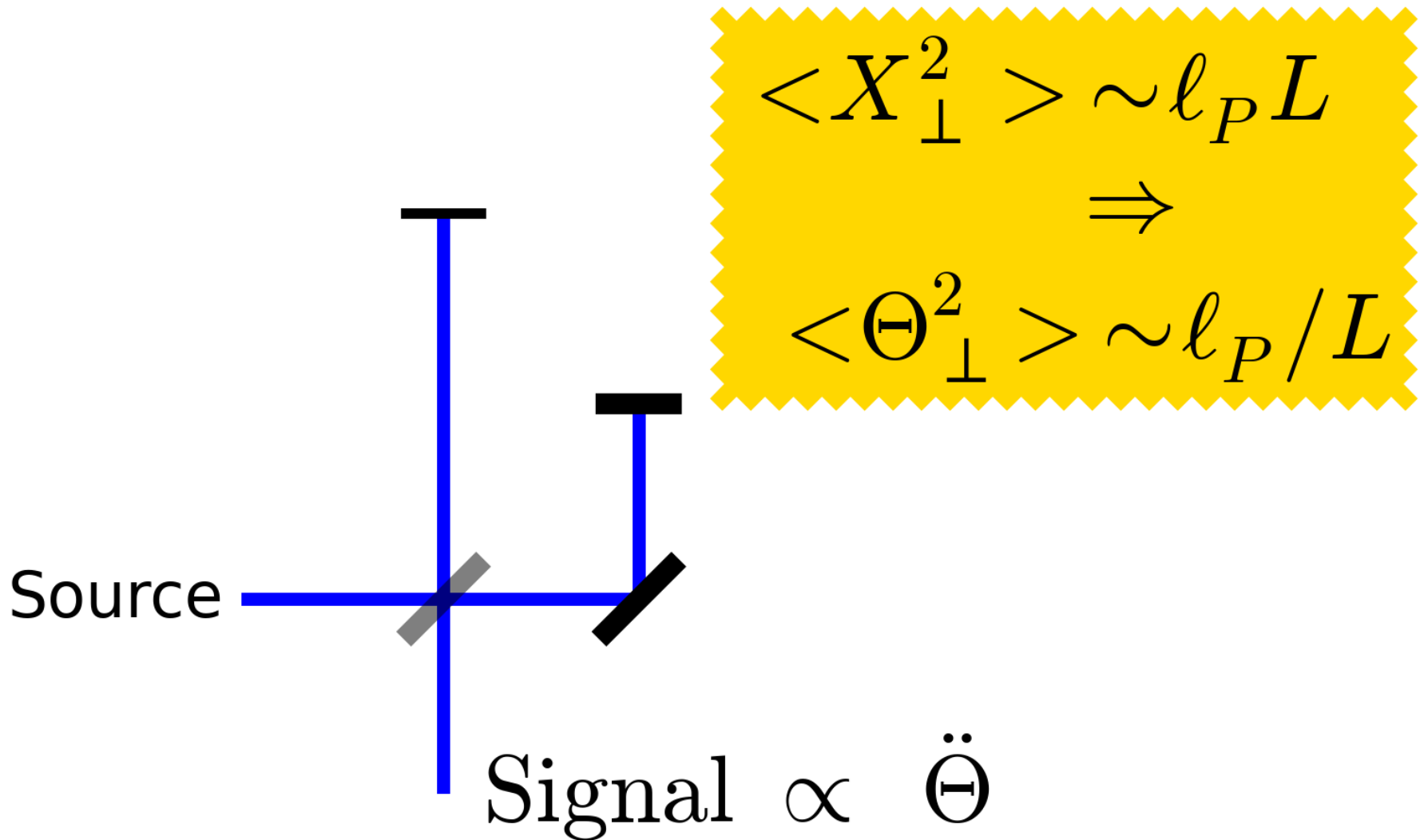


But wait, there's more!

Michelson-Gale-Pearson
(1925) measured Earth's
rotation rate.



Single Bent Arm IFO



Conversion to Bent Arms



Conclusions

- E990 – The Fermilab Holometer – completed on time and budget
- We see no evidence for quantum geometry in the shear measurements – to $\sim 1\%$ of l_p
- Same equipment can be used for a new measurement
- Civil and mechanical work for the bent arm interferometers is finishing now
- Expect a measure of exotic quantum rotation in a year

Aaron Chou, Craig Hogan,
Ray Tomlin, Stephen Meyer,
Brittany Karnai, Lee McCuller,
Jonathan Richardson, Chris
Stoughton, Rainier Weiss
and Richard Gustafson