Hanbury Brown and Gravitational Waves

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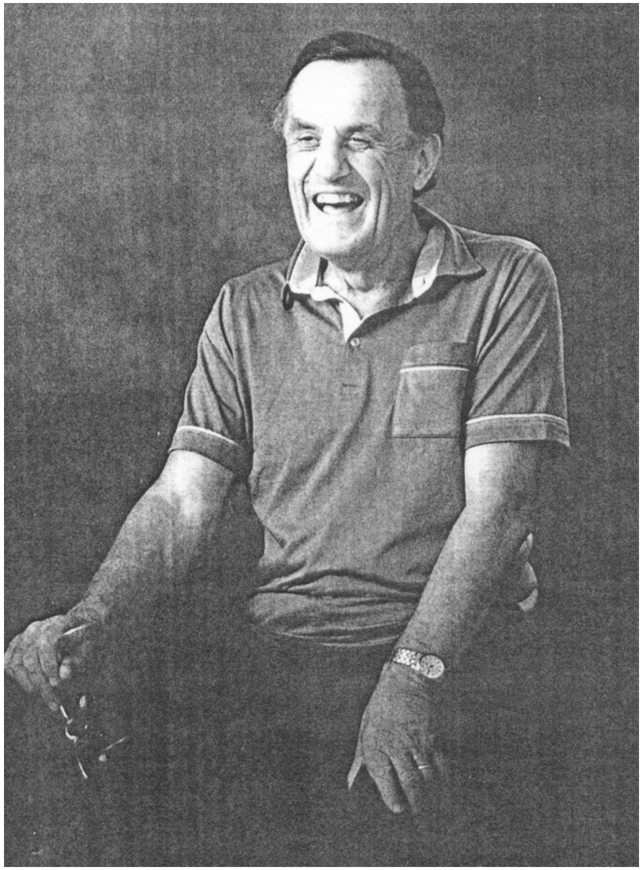
Robert Hanbury Brown

a role model for laboratory scientists

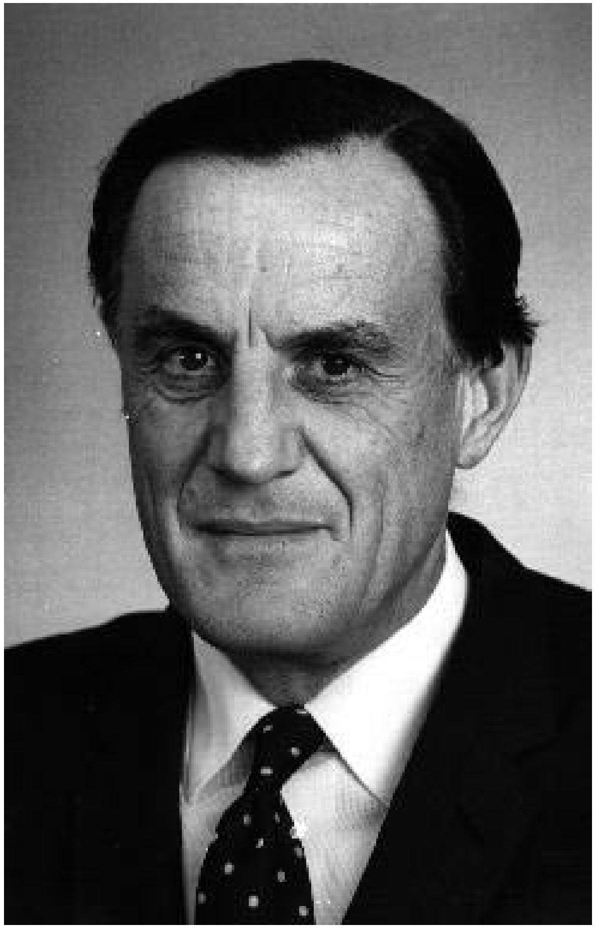


- **Tonbridge School**
  - » **Studied classics – Greek and Latin**
- **Brighton Technical School**
  - » **Studied engineering**
- **Scholarship to Imperial College**

- **Sir Henry Tizard, Rector, convinced him to defer his PhD studies to do some interesting 'research' for the Air Ministry as radio engineer for £214 / year**
- **He developed into an inventive "laboratory scientist" having a long diverse and productive career**

Hanbury Brown

scientific and technical contributions



- **Radar (1936)**
- **Radio Astronomy (1949)**
- **Interferometry (1954)**
- **Quantum optics**

Hanbury Brown
radar

- **Original Concept – enquiry from Air Ministry in 1935 to Robert Watson Watt**
  - » **"a death ray" → can you incapacitate an enemy aircraft by an intense radio beam? Watt responded showing that it would take unrealistic radio power, even neglecting shielding of metal of the aircraft. But, he added a proposal for "radio detection as opposed to radio destruction"**
  - » **H. Brown as a "radio engineer" joined the team to develop this detection. (Aside from posted observers the only technical method used to spot enemy aircraft attack at that time was sound locators, which were too slow to give useful information on location of aircraft)**
  - » **After ups and downs for 4 years, it proved to be of vital importance in the "Battle of Britain" in 1940. H. Brown contributed important radio engineering and implementation of the system.**

Hanbury Brown

radar engineer and a “boffin”

- **Airborne Radar – put complex instrumentation on aircrafts and train crew**
  - » **Needed short wavelength, adequate power, etc**
  - » **Bombing the bomber**
  - » **Radar in the dark**
  - » **Detecting submarines**
  - » **Confusion from multiple aircraft**

- **Wing Commander Peter Chamberlain tagged the word “Boffin” to describe the scientists who put these strange devices on their airplanes.**
  - » **Hanbury Brown was proud of this label, which apparently was especially pointed at him. He thought it describes a type of scientist who does not stay in the backroom, but rather ‘pokes his nose into other peoples business.’ Basically, a “boffin” is a middleman, a bridge between two worlds**

Radio Astronomy

- **In 1949, visited Bernard Lovell and his group at at Jodrell Bank who had a 218 foot fixed paraboloid that was built to detect radar echoes from cosmic rays.**
- **He joined the group to develop radio techniques to do astronomy, a whole new field for him.**
- **This led to radio maps of extragalactic objects and motivated the development of interferometers to measure angular sizes of such objects.**

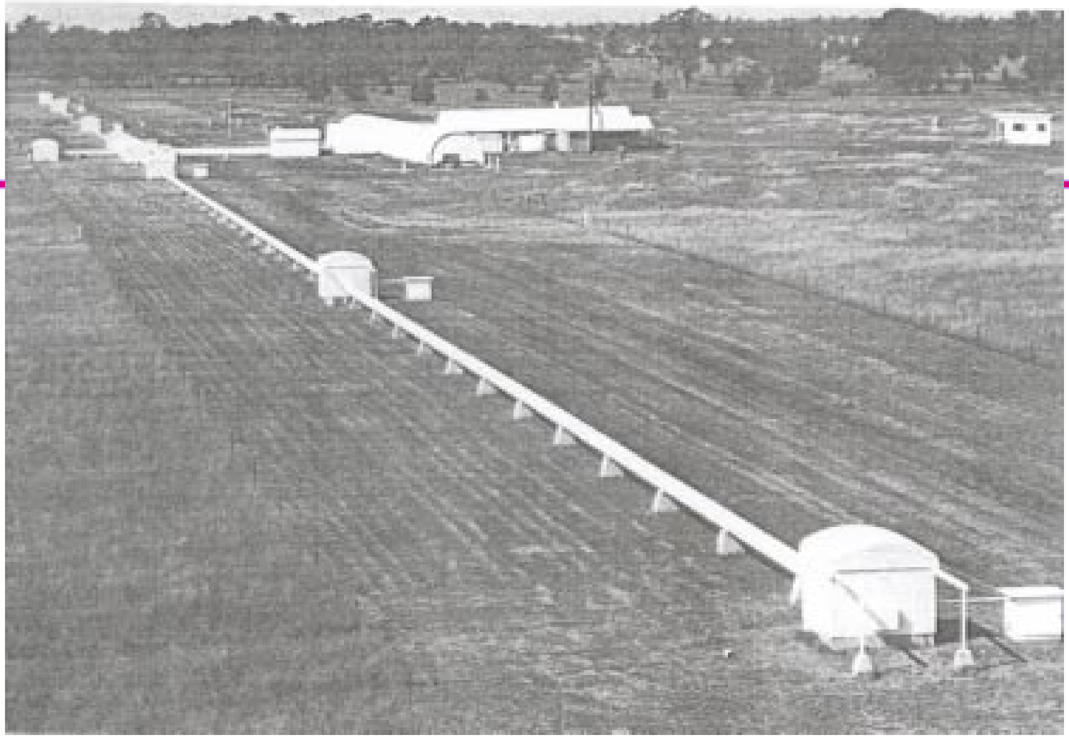
See talk by Chantler ….. Development and exploitation of Brown-Twiss interferometer and subsequent developments

Hanbury Brown and Twiss Intensity Interferometry

from stars to nuclear collisions

In the 1950's Hanbury Brown and Twiss showed that one could measure the angular sizes of astronomical radio sources and stars from correlations of signal intensities in independent detectors. Since that time intensity interferometry has become a very important technique in high energy nuclear and particle collisions, probing the space-time geometry of the collision. The effect is one of the few measurements in elementary particle detection that is sensitive to the wave mechanics of the produced particles

Long Baseline Interferometry



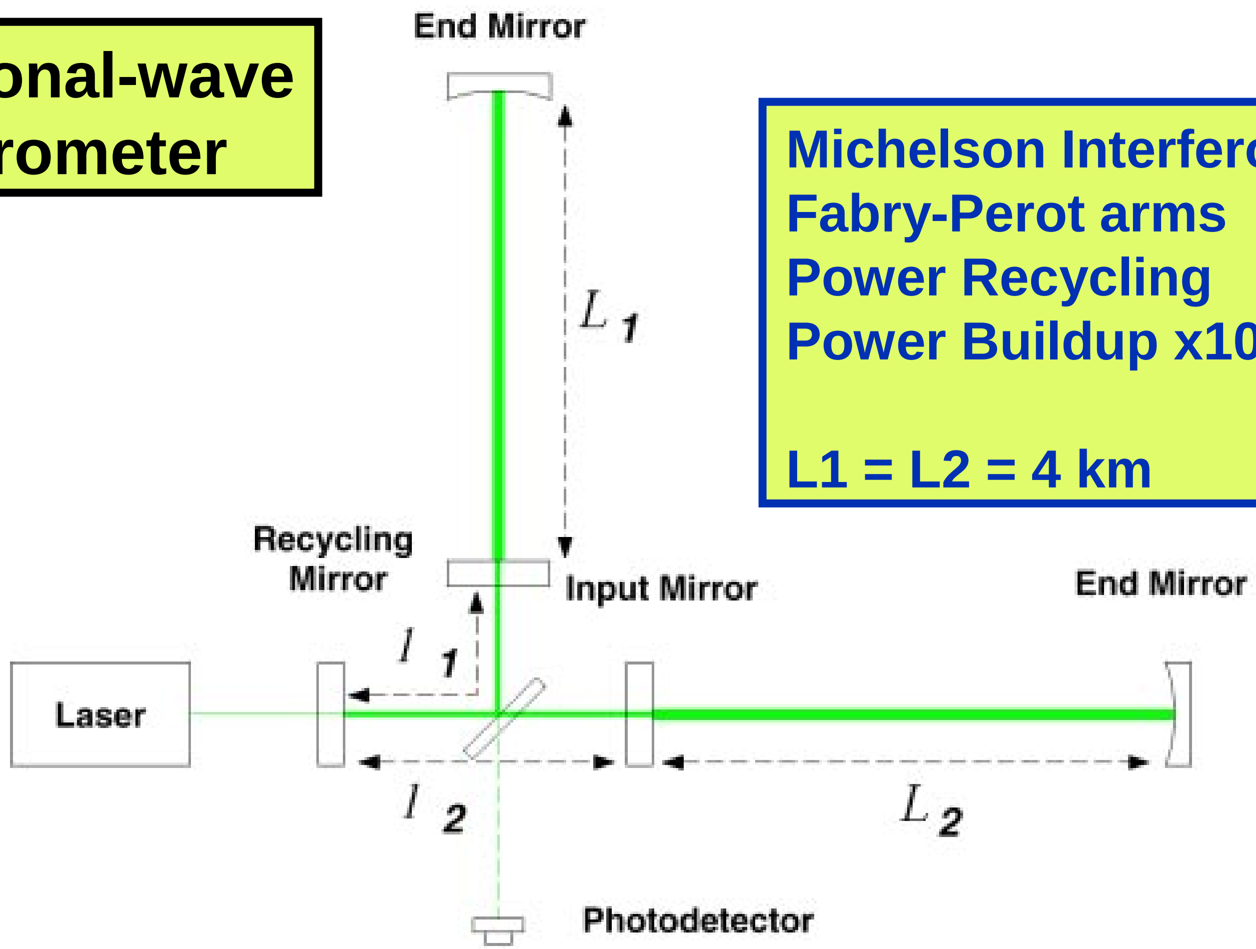
Sydney University
Stellar Interferometer

Laser Interferometer
Gravitational-wave
Observatory
LIGO

Long Baseline Interferometers

basic optical configuration

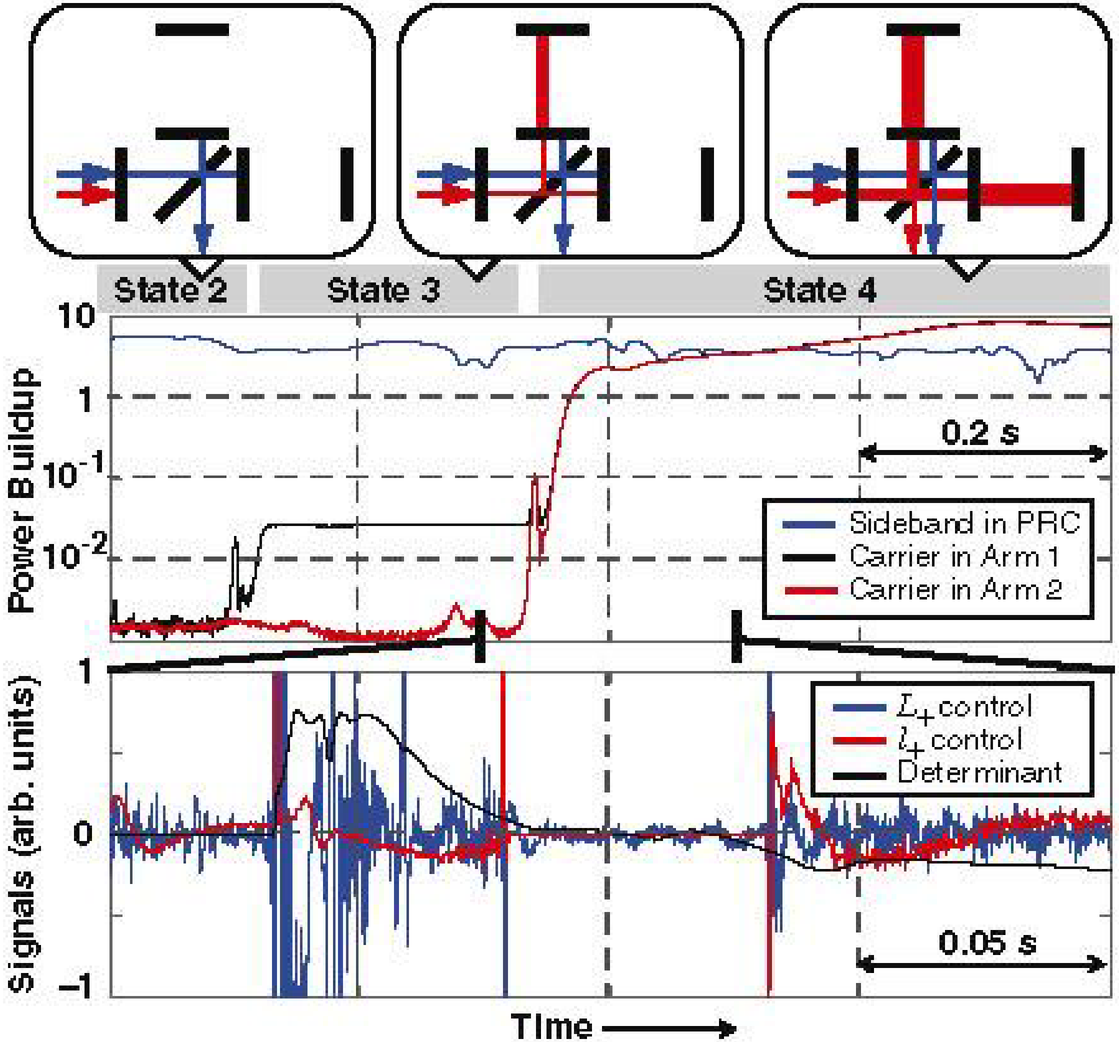
Gravitational-wave Interferometer



Michelson Interferometer
Fabry-Perot arms
Power Recycling
Power Buildup x10^4

L1 = L2 = 4 km

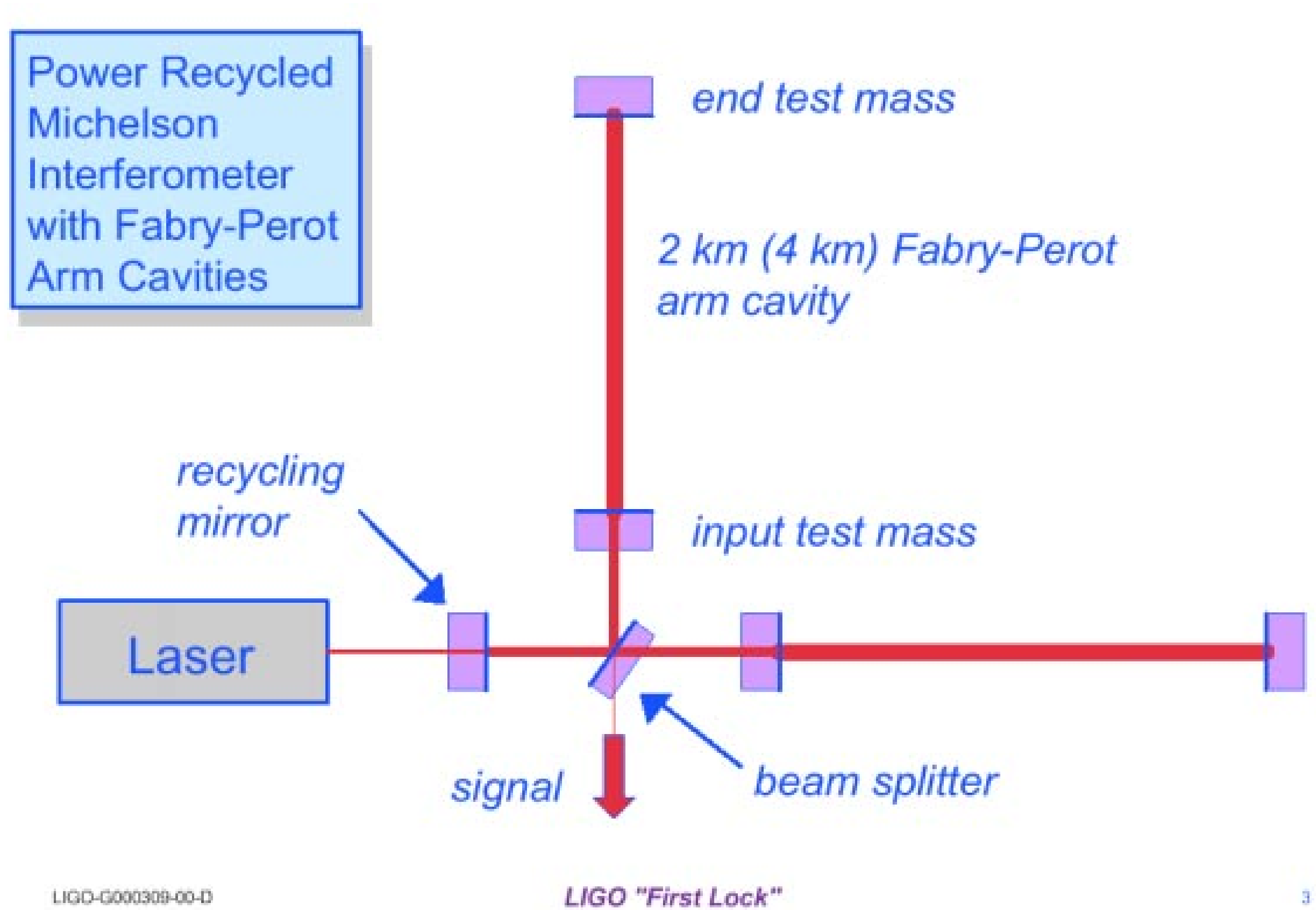
Lock Acquisition



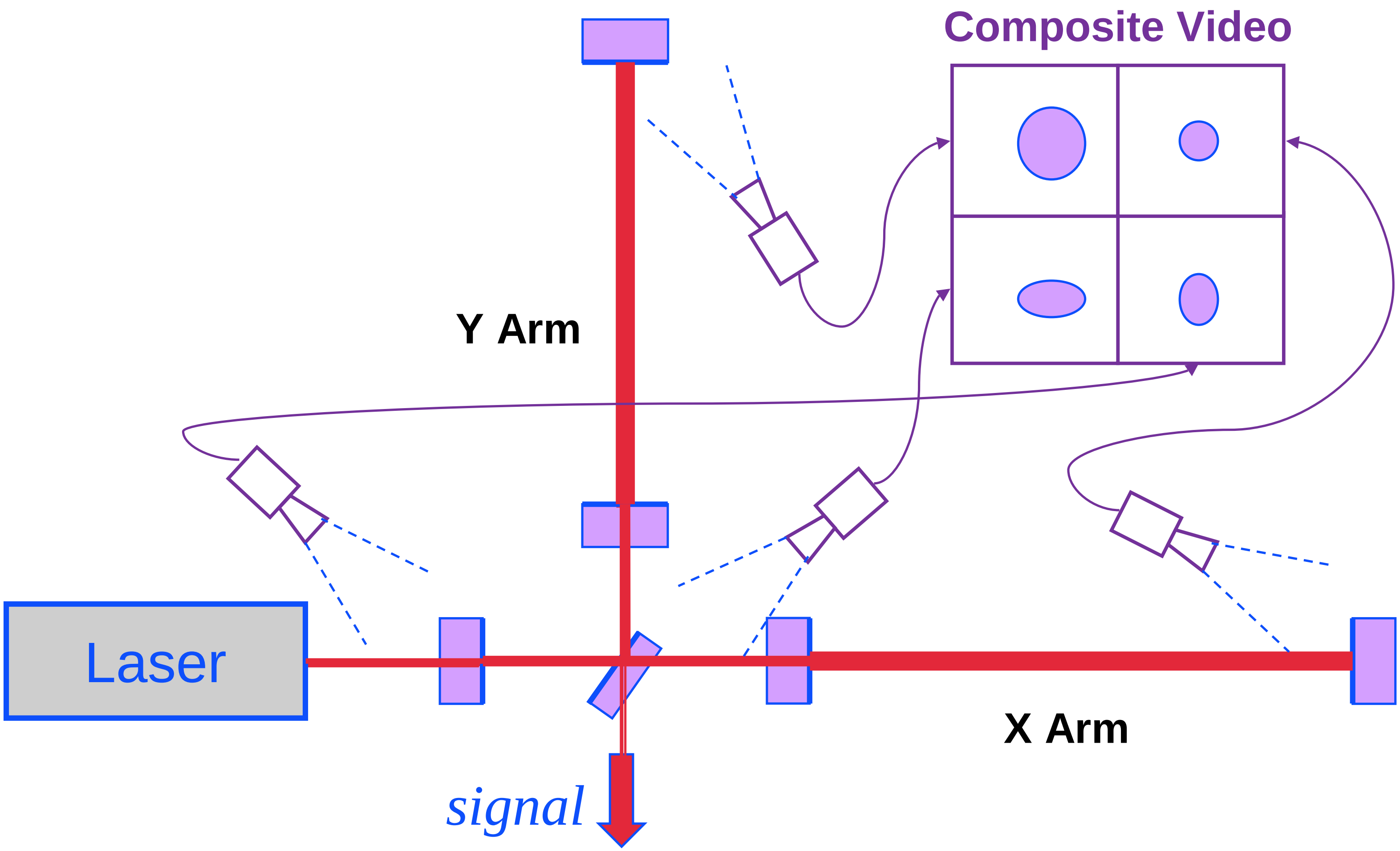
Why is Locking Difficult?

	One meter, about 40 inches
÷10,000	*Earthtides, about 100 microns*
÷100	*Microseismic motion, about 1 micron*
÷10,000	*Precision required to lock, about 10^{-10} meter*
÷100,000	*Nuclear diameter, 10^{-15} meter*
÷1,000	*LIGO sensitivity, 10^{-18} meter*

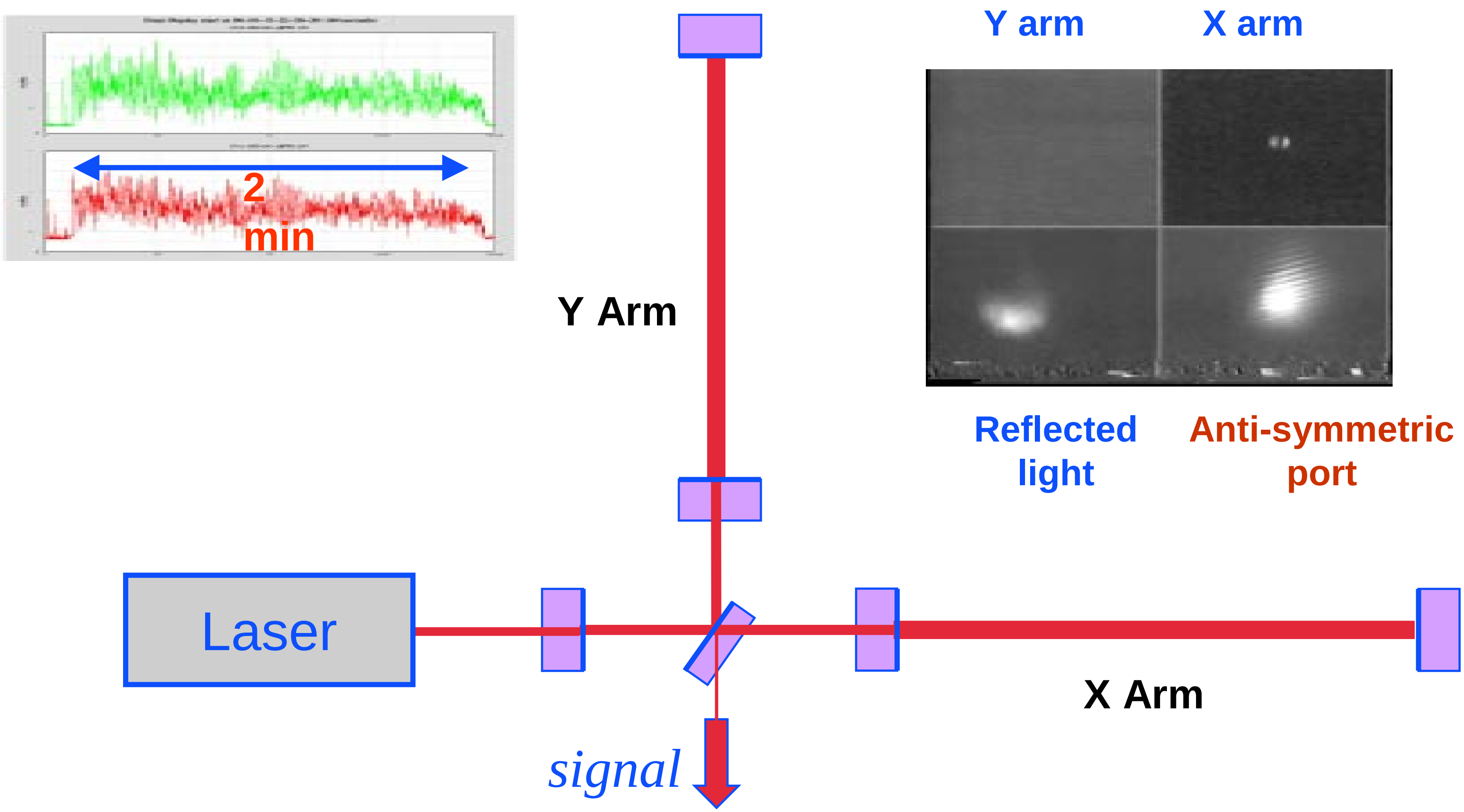
Locking the Interferometer
power buildup



LIGO
locking sequence



Watching the Interferometer Lock



Interferometry
astronomy and gravitational-waves

Astronomy

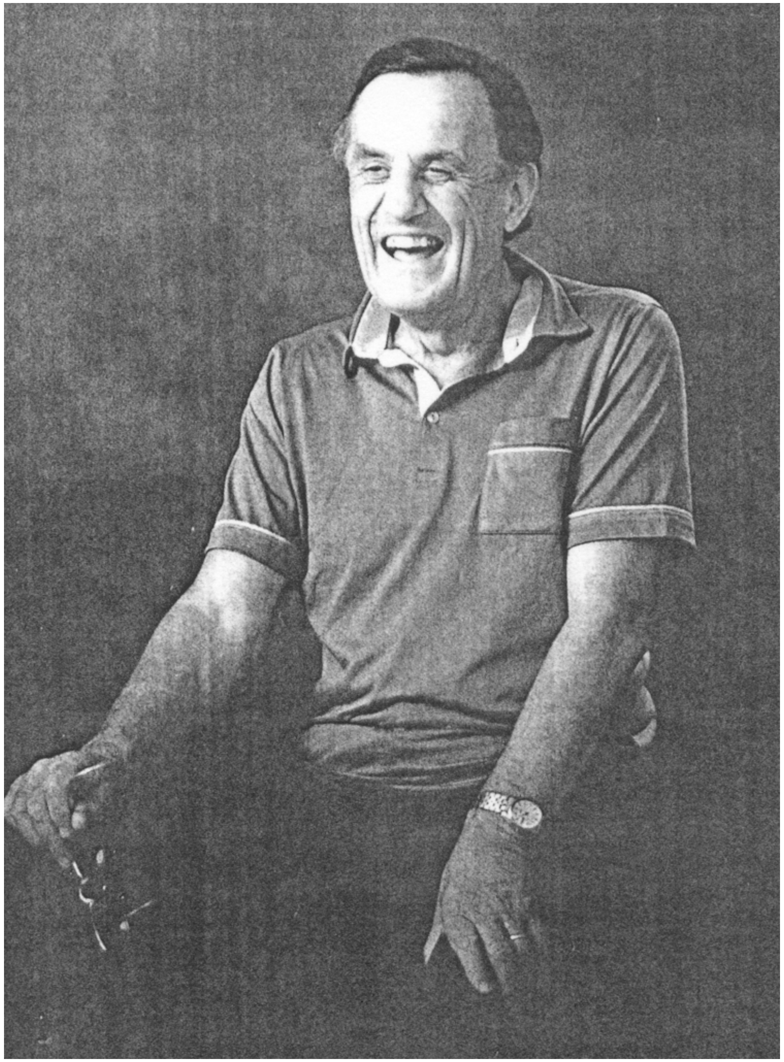
One of the biggest contributions that interferometry has contributed to astronomy is giving an accurate measure of the diameter of stars. Over 100 stellar diameters have been measured, ranging from 0.4 to 5.5 milliarcseconds, sometimes with 1 percent accuracy. With accurate measures of star diameters, astronomers will be able to deduce apparent brightness, luminosity, and study orbits of binary stars.

Gravitational-waves

One of the biggest potentials for interferometry in gravitational waves has to do with measuring the size and geometric shape of compact stars – neutron stars. This will be done by tracking such periodic sources and measuring there frequency and detailed doppler shifts.

Hanbury Brown

relevance of basic research



"The popular, often self-righteous and apparently innocuous demand that all research should be relevant to our social needs is one of the greatest dangers to the advancement of science. To insist on relevance in basic research is rather like insisting on naturalism in art; if you are successful you end up with something not radically new, but comfortably familiar."