LIGO

# *LIGO Overview*

*for the LIGO Scientific Collaboration*

35th COSPAR meeting
Paris
21 July 2004

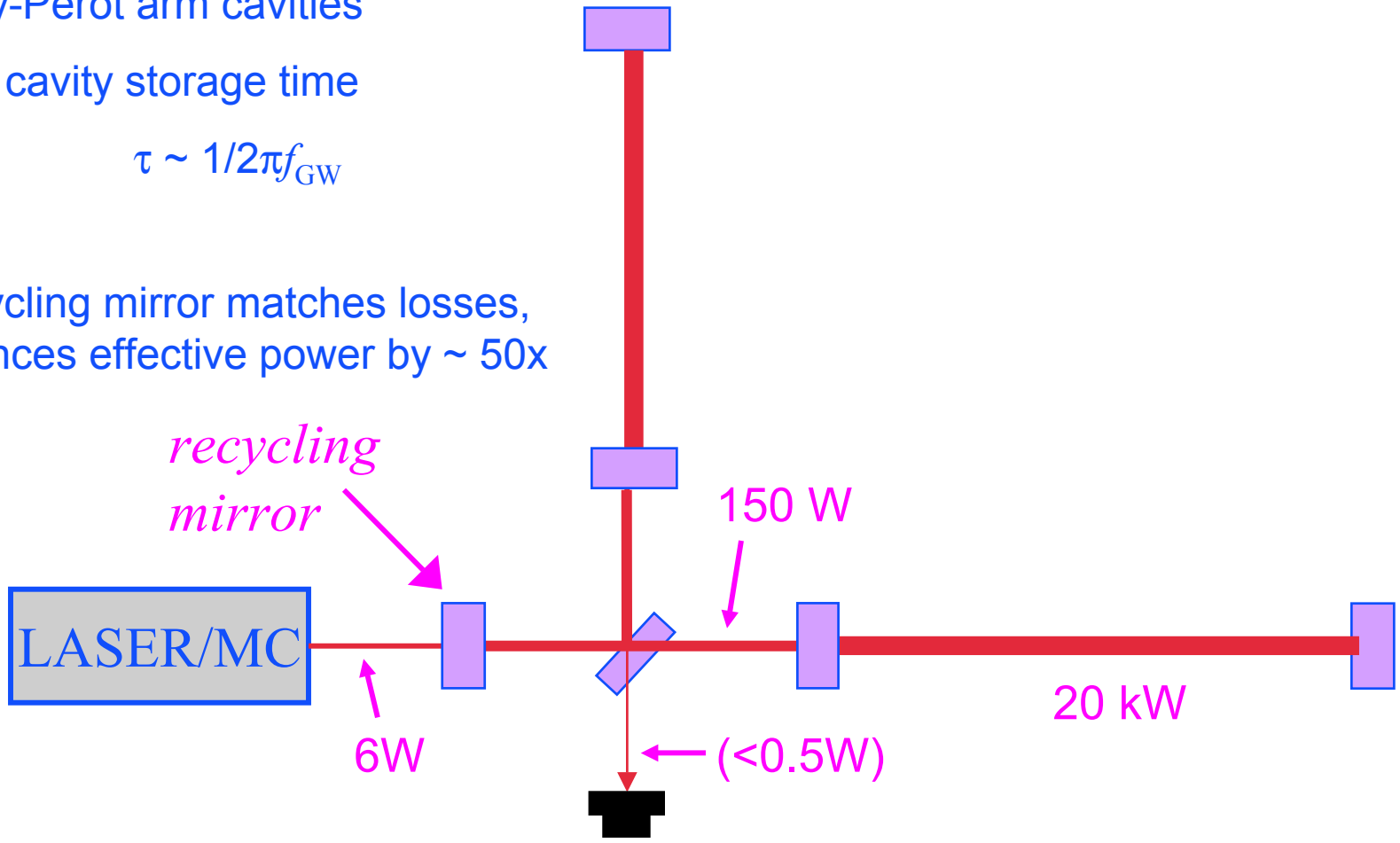
# LIGO Observatories

# LIGO Interferometer Optical Scheme

- Michelson interferometer with Fabry-Perot arm cavities
- Arm cavity storage time

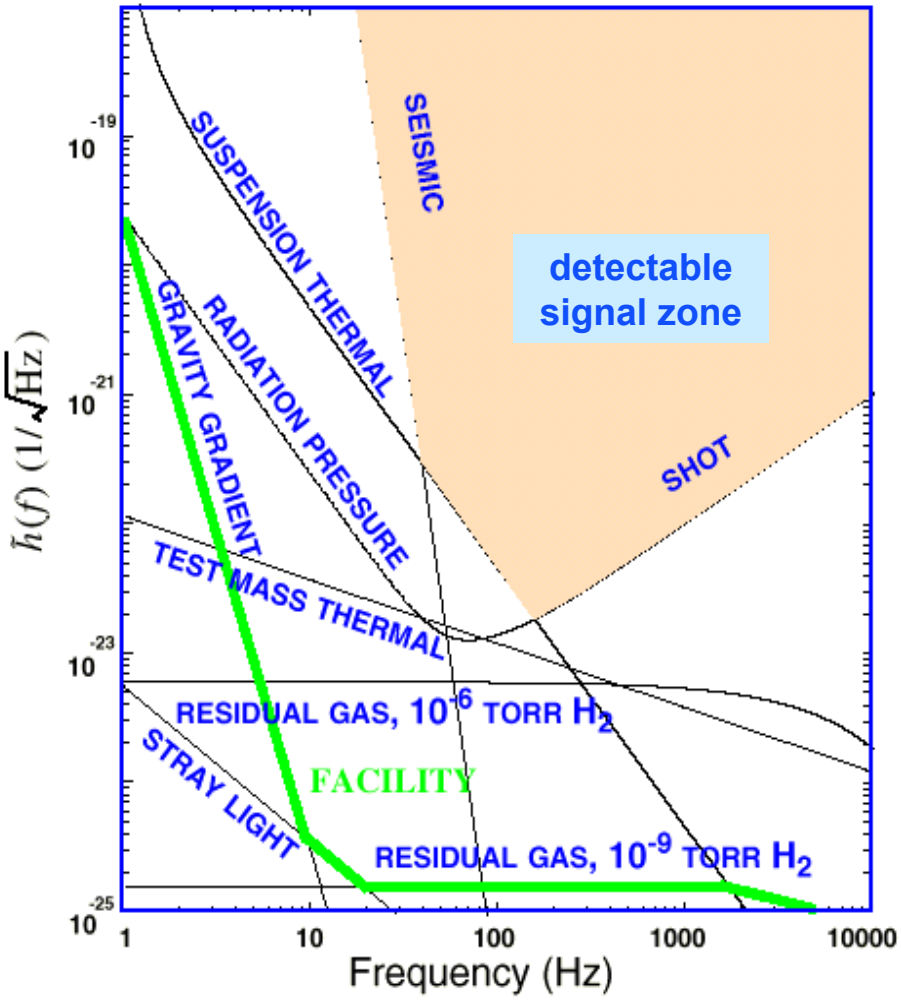
$$\tau \sim 1/2\pi f_{GW}$$

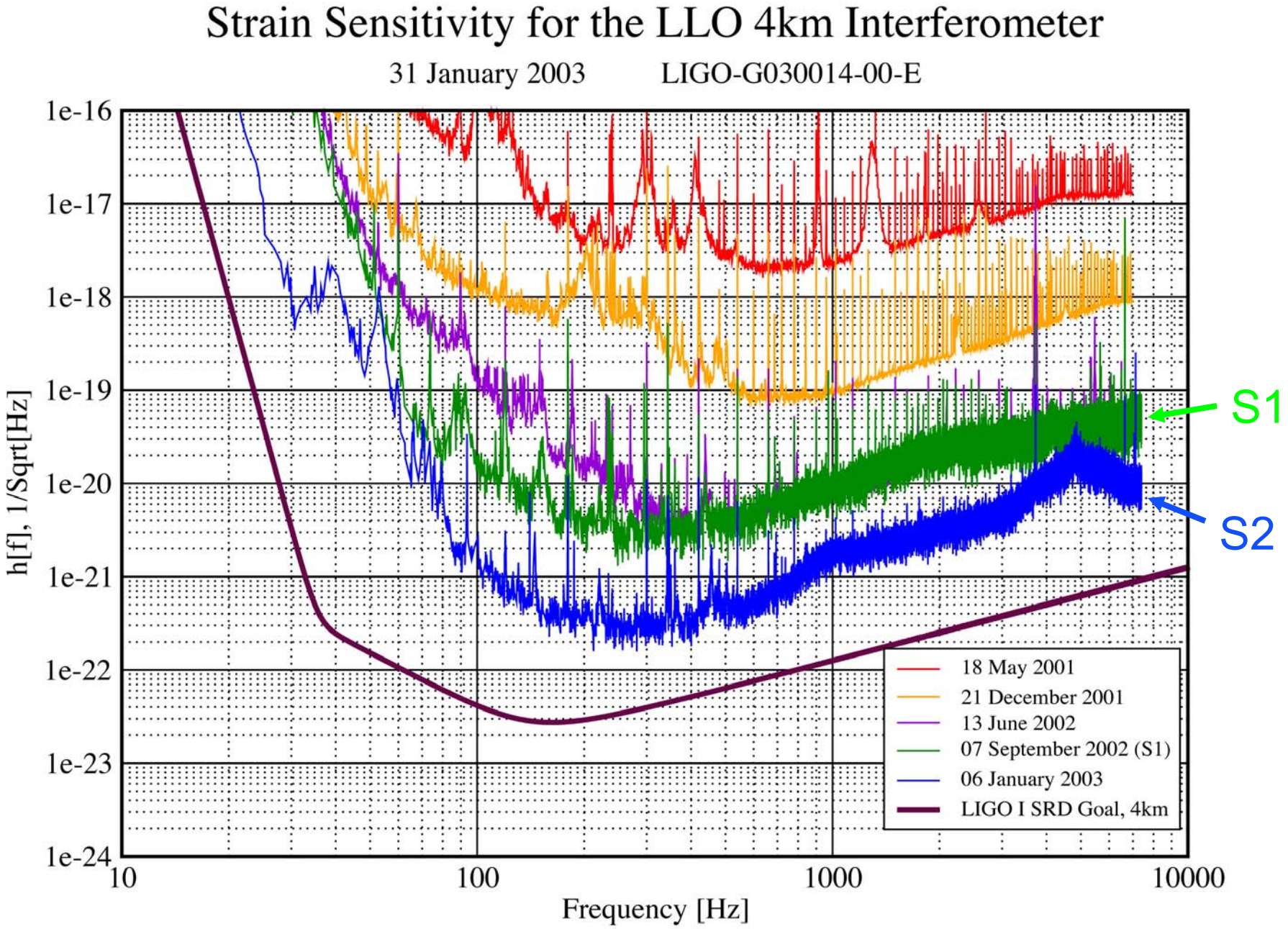
- Recycling mirror matches losses, enhances effective power by ~ 50x



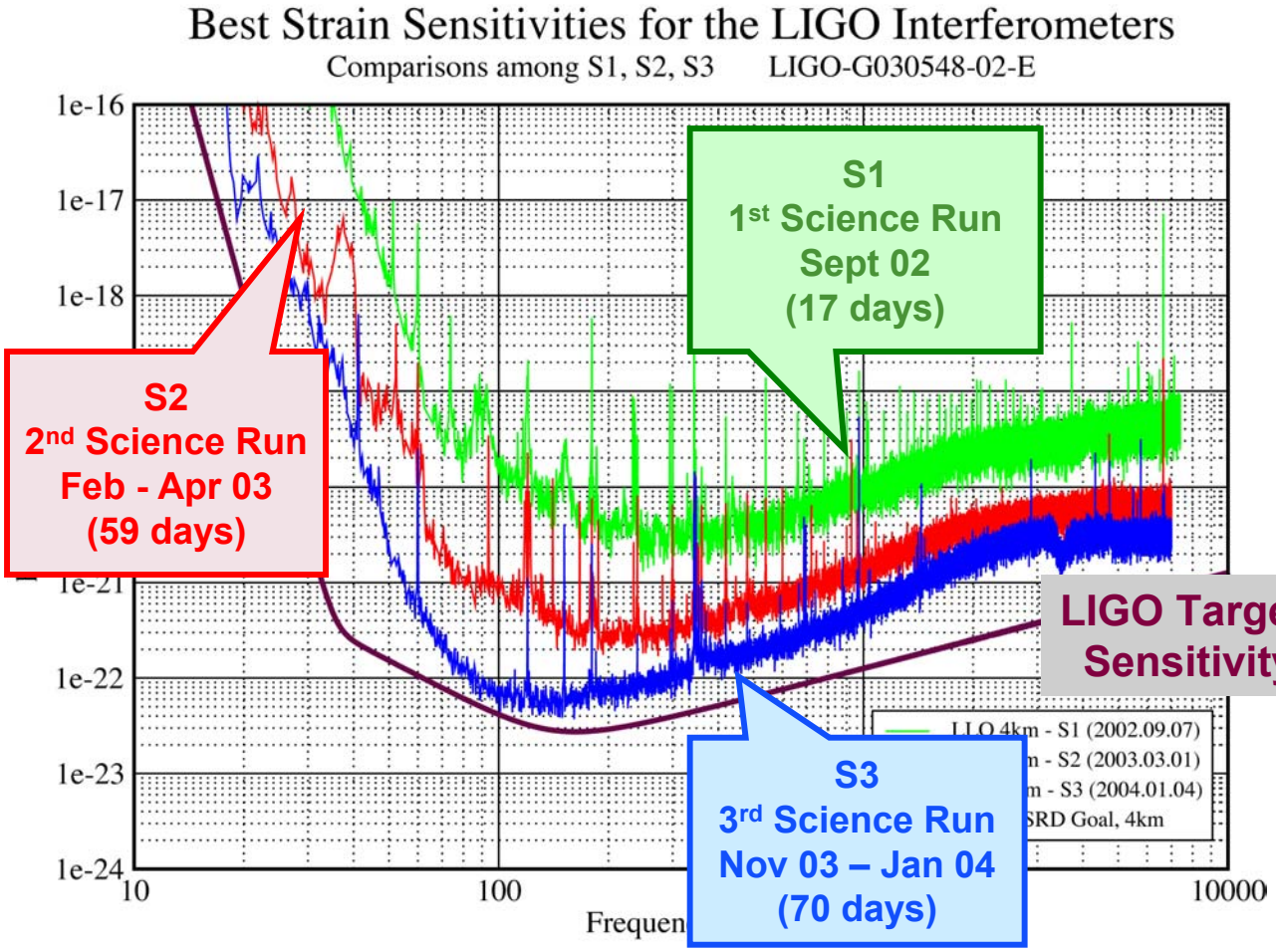
# LIGO Interferometer Design Noise Budget

- "Fundamental" limits (with then-current technology) determined design goals
  - **seismic** at low frequencies
  - **thermal** at mid frequencies
  - **shot noise** at high frequencies
- Facility limits much lower to allow improvement as technology matures
- Other "technical" noise not allowed above 1/10 of these (by design, anyway...)




Strain Sensitivity for the LLO 4km Interferometer
31 January 2003
LIGO-G030014-00-E
h[f], 1/Sqrt[Hz]
1e-16
1e-17
1e-18
1e-19
1e-20
1e-21
1e-22
1e-23
1e-24
10
100
1000
10000
Frequency [Hz]
18 May 2001
21 December 2001
13 June 2002
07 September 2002 (S1)
06 January 2003
LIGO I SRD Goal, 4km
S1
S2

# LIGO Science Runs




| S3 Duty Cycle | |
|---|---|
| Hanford 4km | 69% |
| Hanford 2km | 63% |
| Livingston 4 km | 22%* |

*Limited by high ground noise—active seismic upgrade currently underway

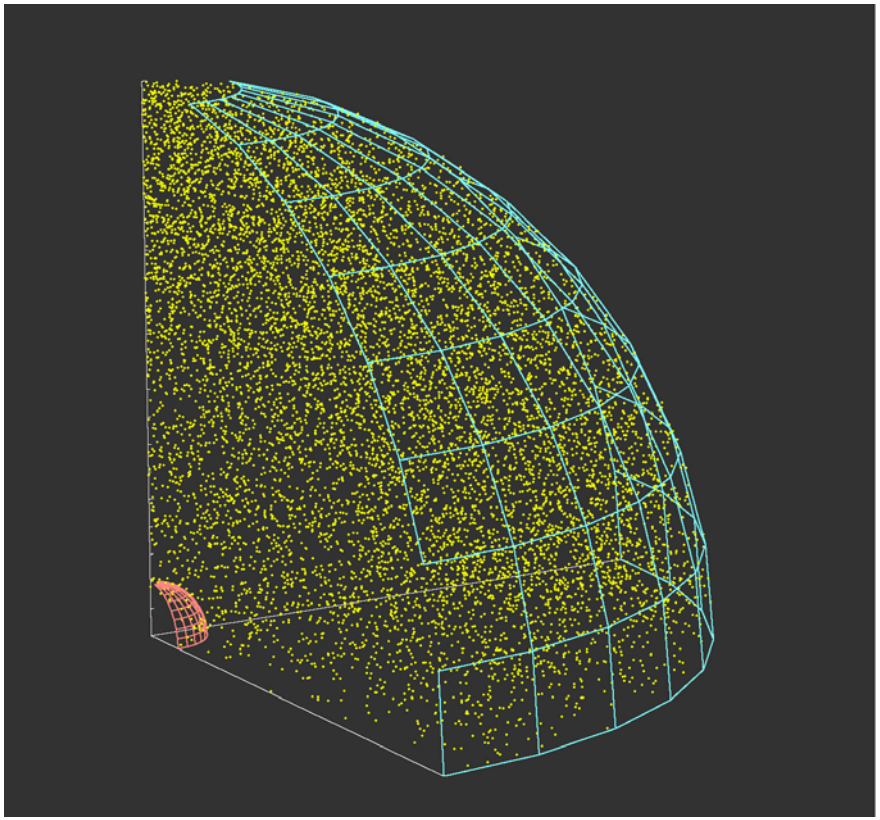
# LIGO Upper Limit Papers Using S1 Data

Papers by the LIGO Science Collaboration (~370 authors, 40 institutions):

- "*Detector Description and Performance for the First Coincident Observations between LIGO and GEO",* Nucl. Inst. Meth A, **517**, 154-179 (2004)
- "*Setting upper limits on the strength of periodic gravitational waves using the first science data from the GEO600 and LIGO detectors*" gr-qc/0308050, Phys Rev D, April 15, 2004
- "*Analysis of LIGO data for gravitational waves from binary neutron stars*", gr-qc/0308069, Phys Rev D, June 15, 2004
- "*First upper limits from LIGO on gravitational wave bursts*", gr-qc/0312056, Phys Rev D, May 15, 2004
- "*Analysis of First LIGO Science Data for Stochastic Gravitational Waves*", gr-qc/0312088, accepted by Phys Rev D

# *Proposed Upgrade:Advanced LIGO*

- Improved detector
  - » Must be of significance for astrophysics
  - » At the limits of reasonable extrapolations of detector physics and technologies
  - » Realizable, practical, reliable
  - » Neither too early nor too late
- Advanced LIGO:
  ~2.5 hours = 1 year of Initial LIGO
  - » Volume of sources grows with cube of sensitivity
  - » >10x in sensitivity; ~ 3000 in rate



- » Begin installation: 2008?
- » Operational: 2011?