VIRGO
CENTRAL INTERFEROMETER
COMMISSIONING

- Setup overview
- Progression
- Sensitivity (m/√Hz)
- Reliability
- Systems
- What we learned

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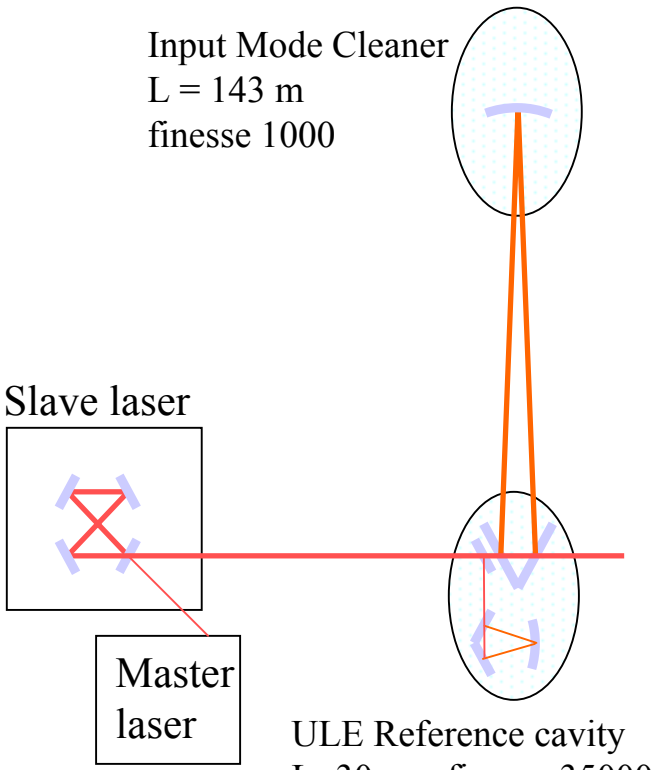
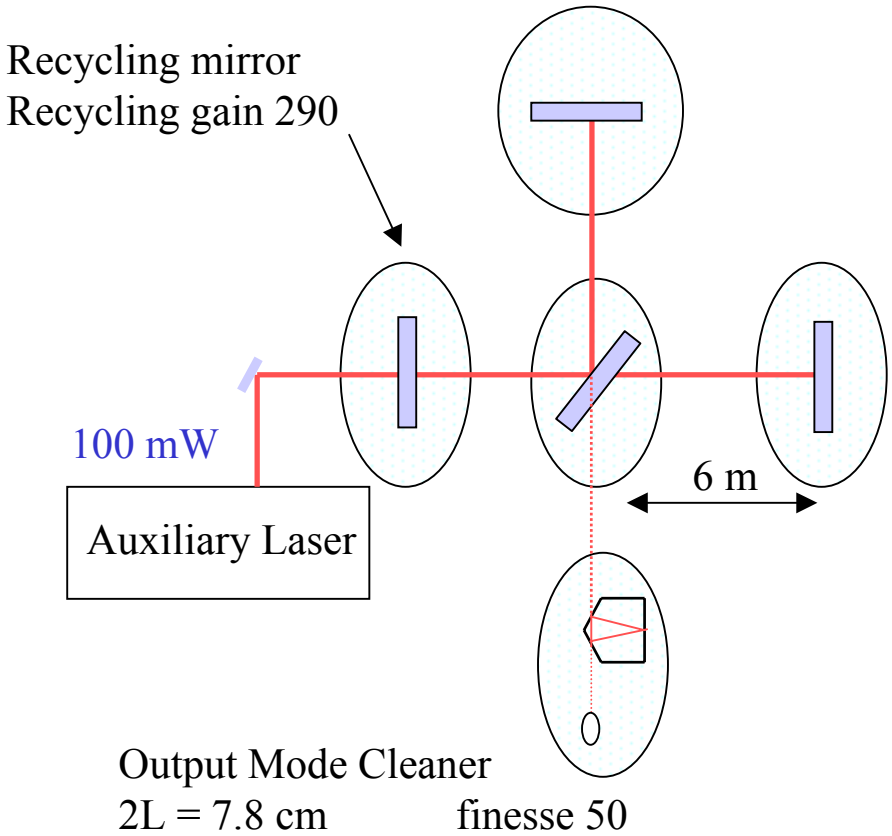
LIGO-G030468-00-Z

Setup up to April 2002

Injection system



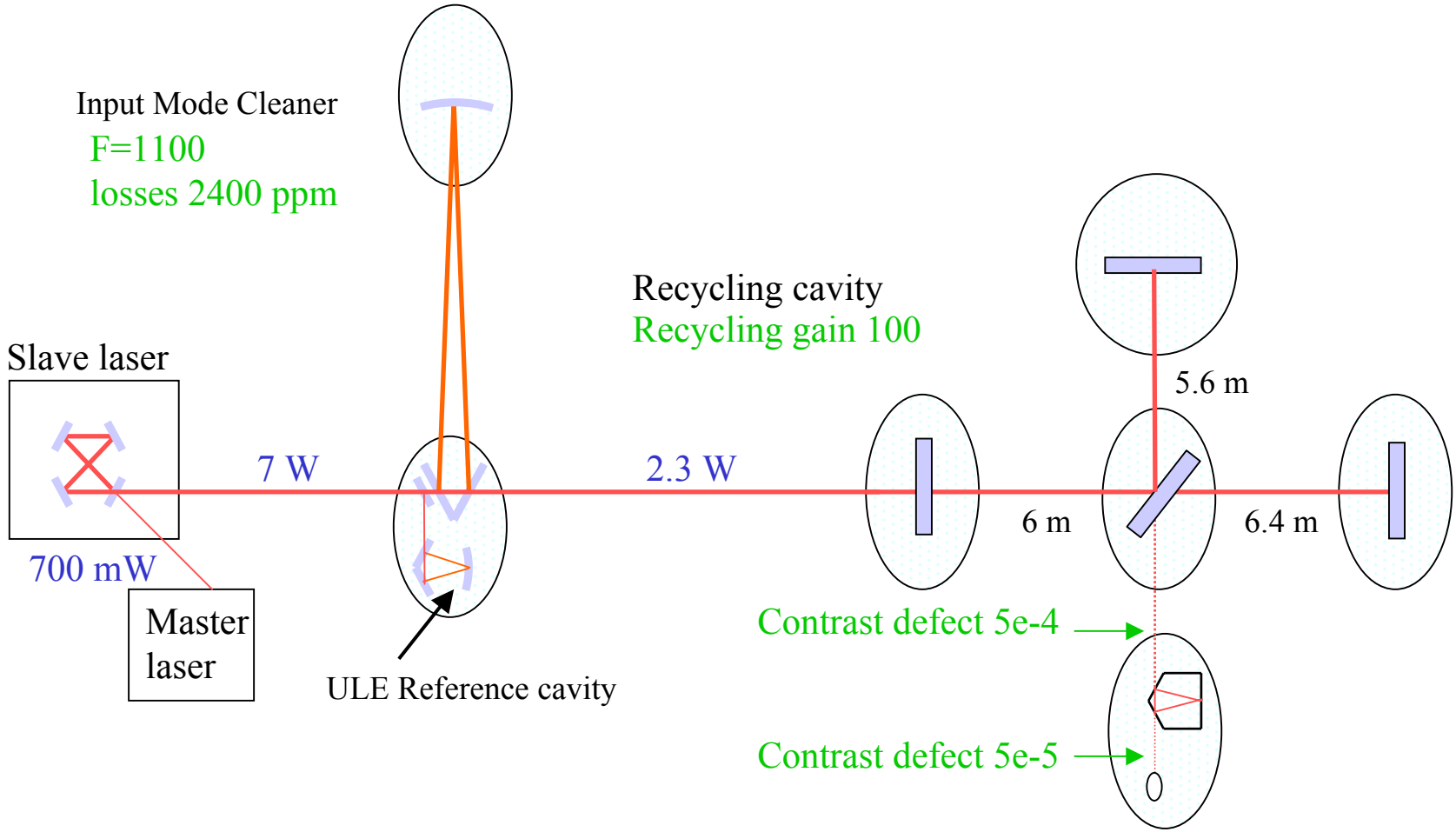
« central interferometer »



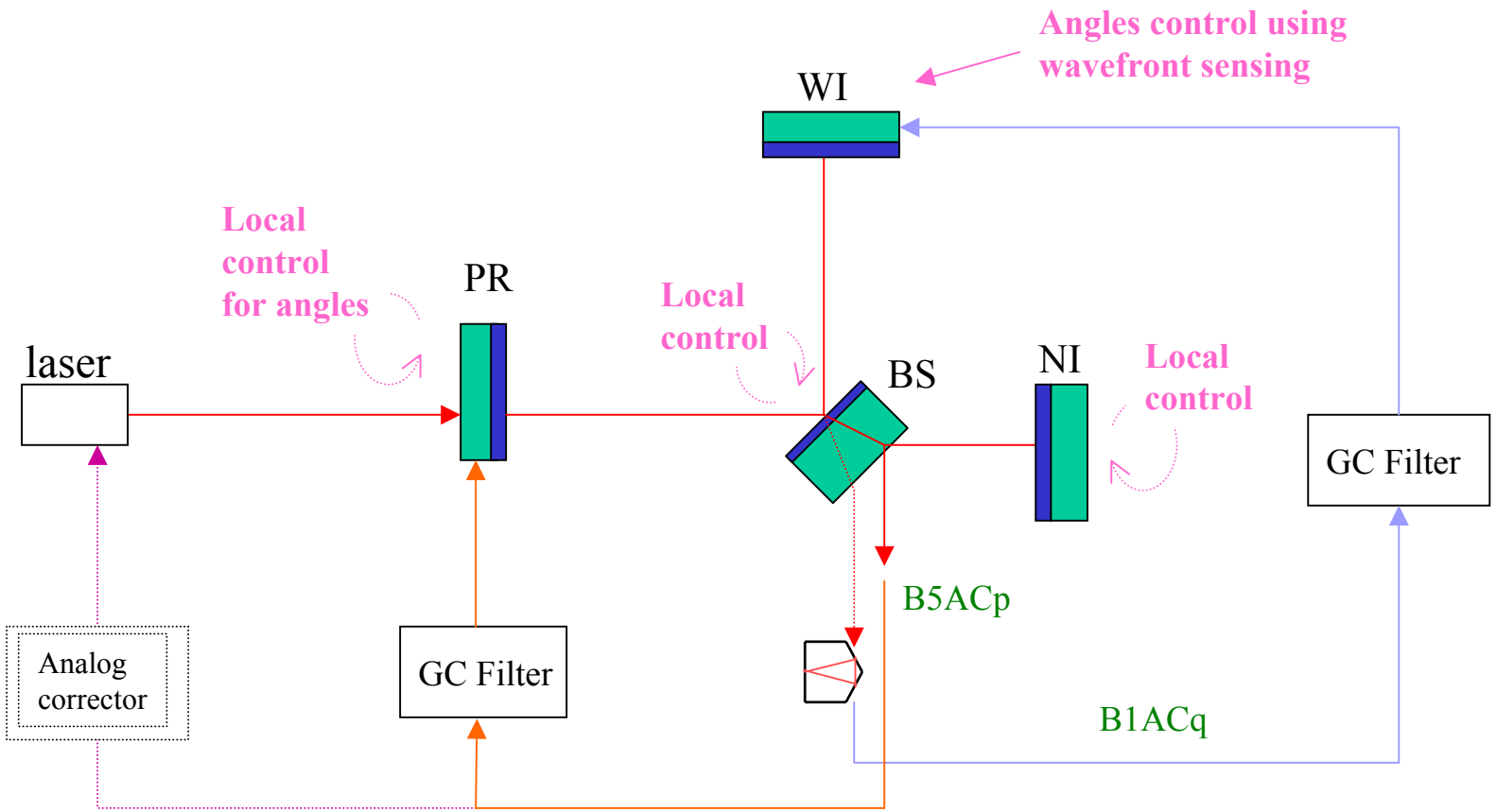
Setup in June and July 2002

Injection system

« central interferometer »



Servo loops to lock the central interferometer

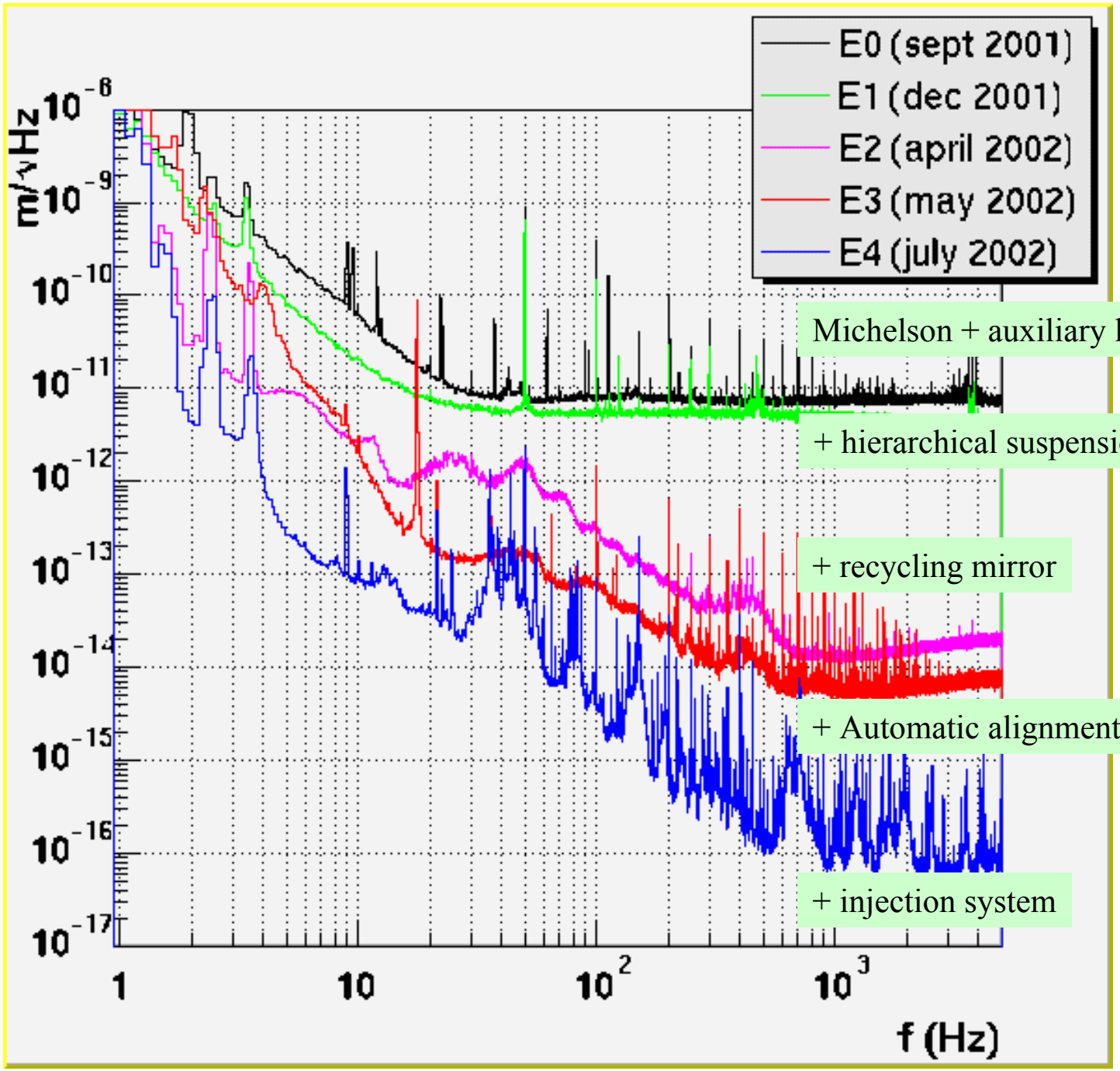


SYSTEMS

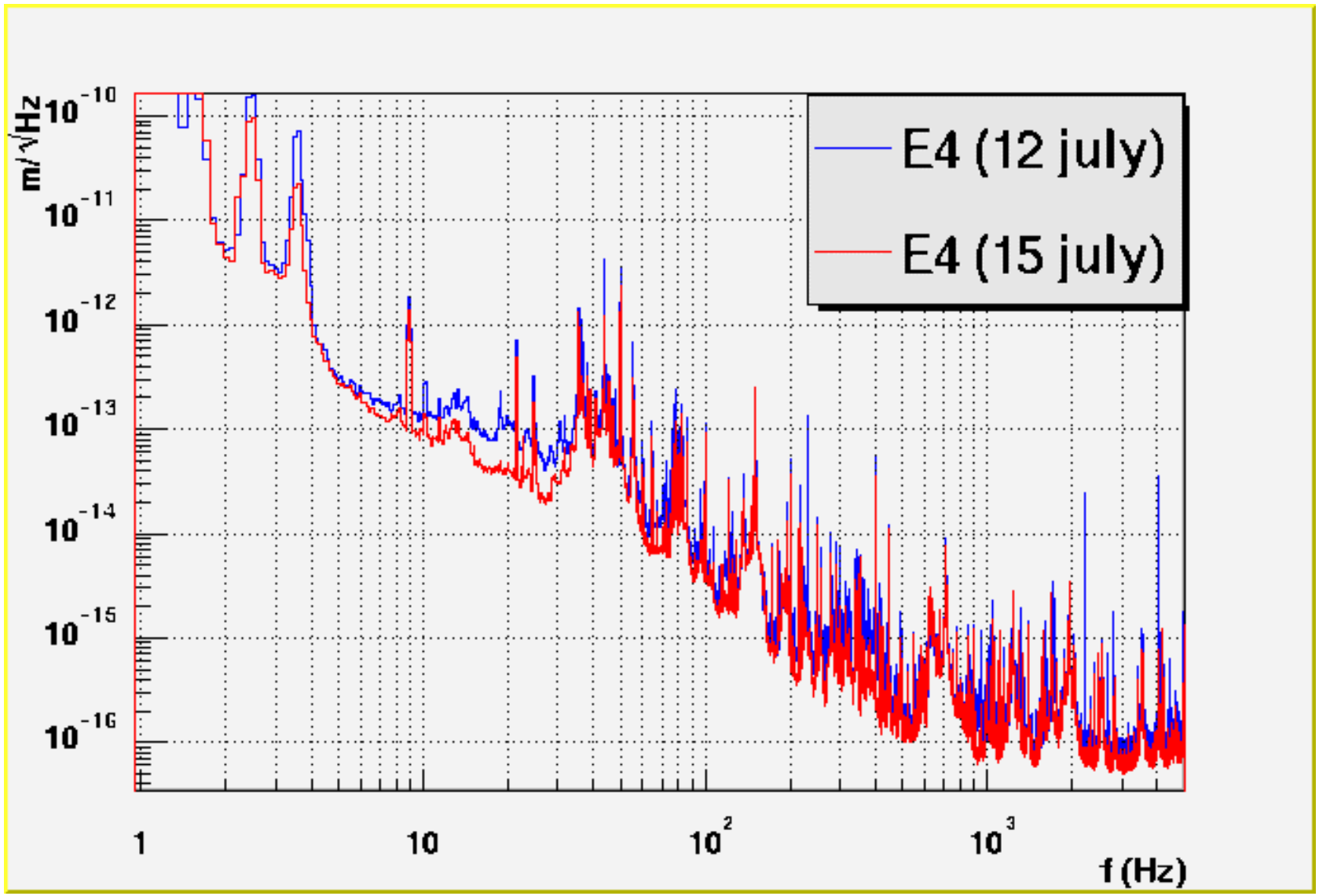
- Mirror suspension and control
  - Inertial Damping
  - Long passive suspensions
  - Suspension last stage – Marionetta – reference mass
  - Local control – position memories
- Light source System
- Signal Detection
- Environment monitoring
- Interferometer control
  - lock acquisition
  - automatic alignment
- Vacuum
- Electronics and Software

VIRGO

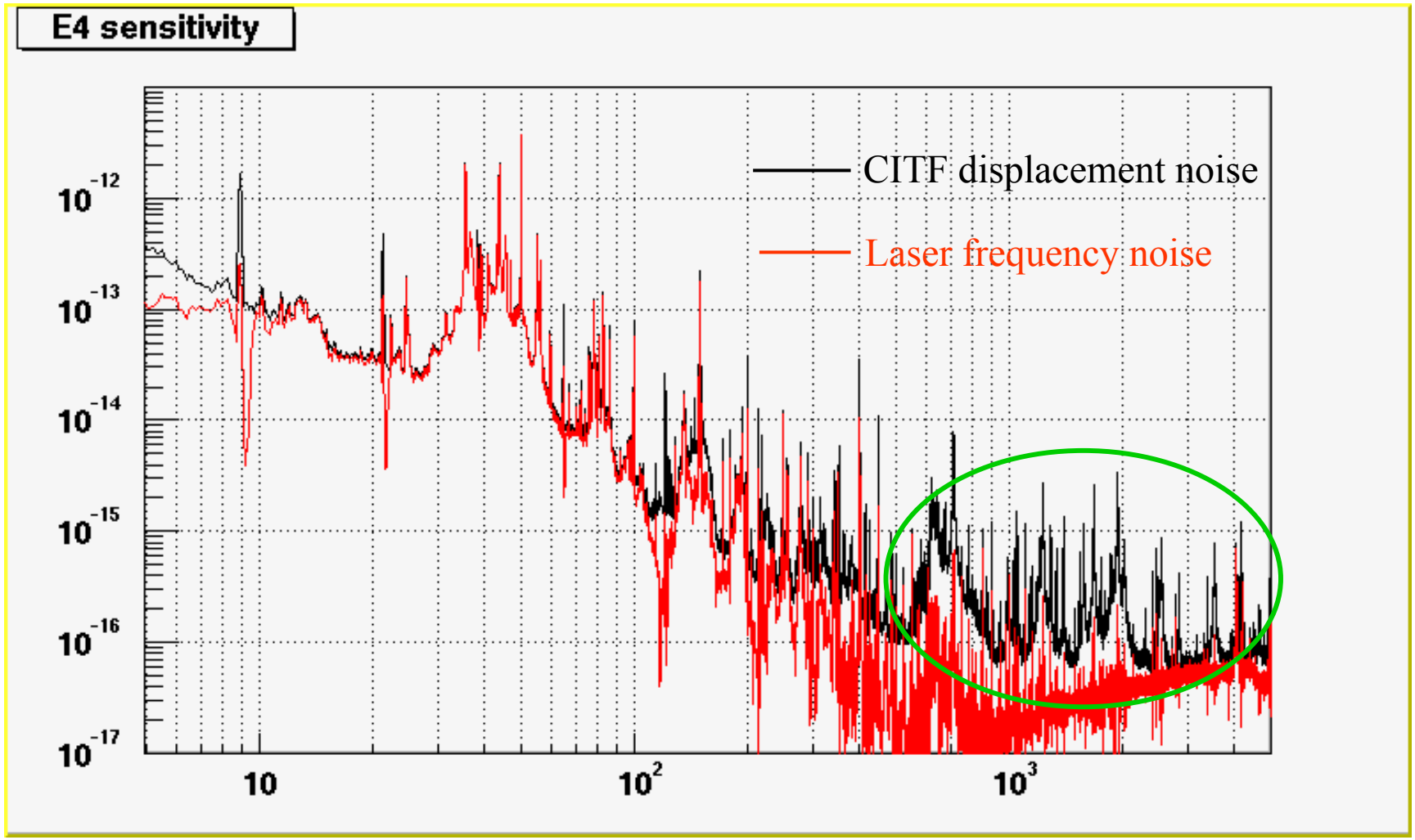
VIRGO Central Interferometer Sensitivity Progress



Engineering Run #4, July 12-15 2002

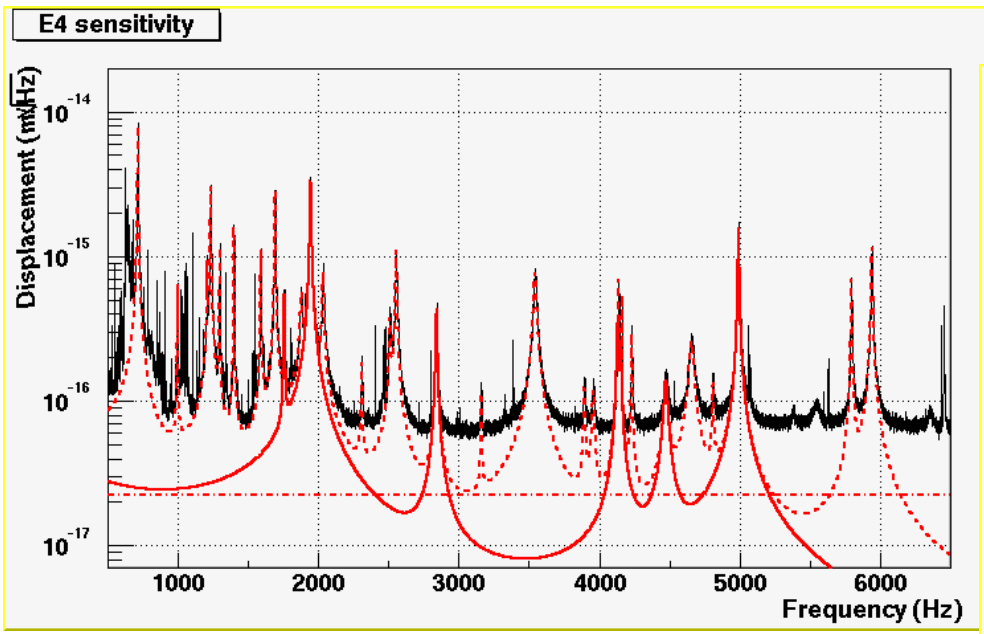


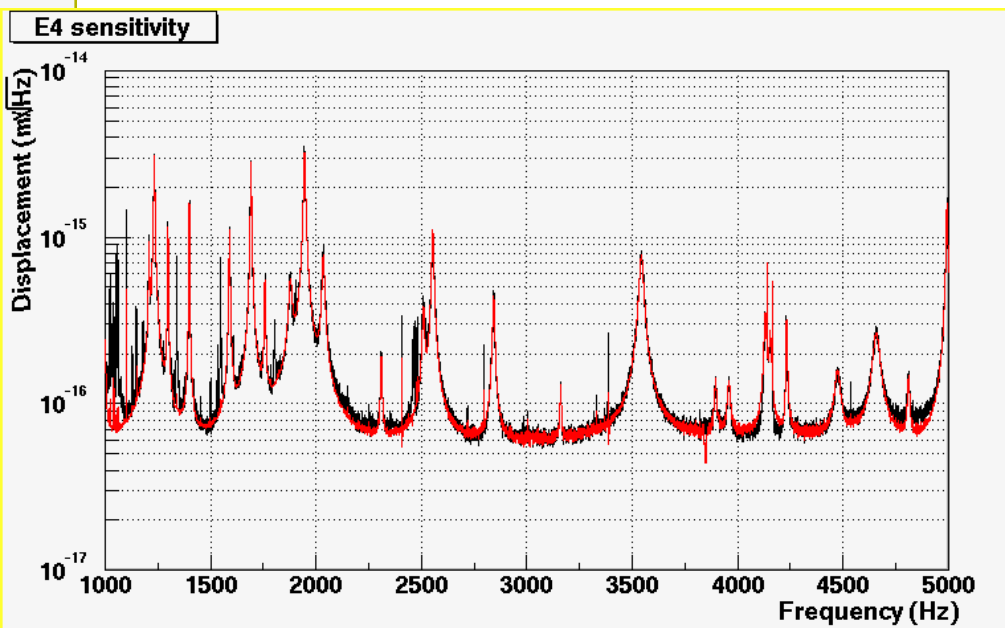
E4 sensitivity (2/3)



E4 sensitivity (3/3)

- Several peaks visible above 700 Hz
- Some identified with west test mass internal resonances
- Others expected to come from the other test masses
- Probably driven by thermal noise (composite test masses)

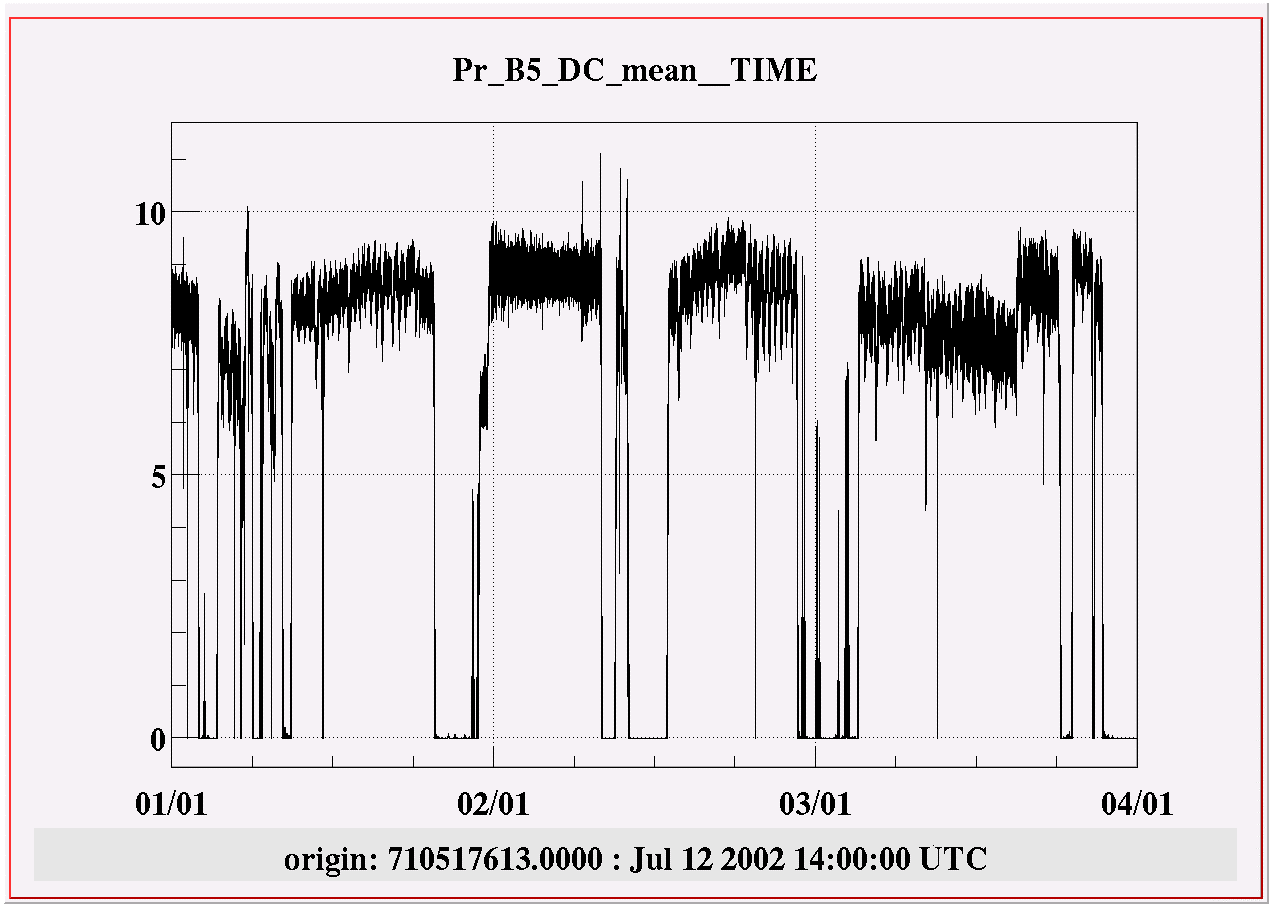




IMPORTANT: will disappear with final monolithic mirrors

E4 Reliability (1/3)

Power in recycling cavity vs. time (3 days)



- 5 unwanted losses of lock (similar to previous runs)
- lock acquisition longer than before ⇒ duty cycle ~ 80%

E4 Reliability (2/3)

- Large duty cycles during E0, E1, E2 and E3 (smaller during E1 due to an hardware failure)

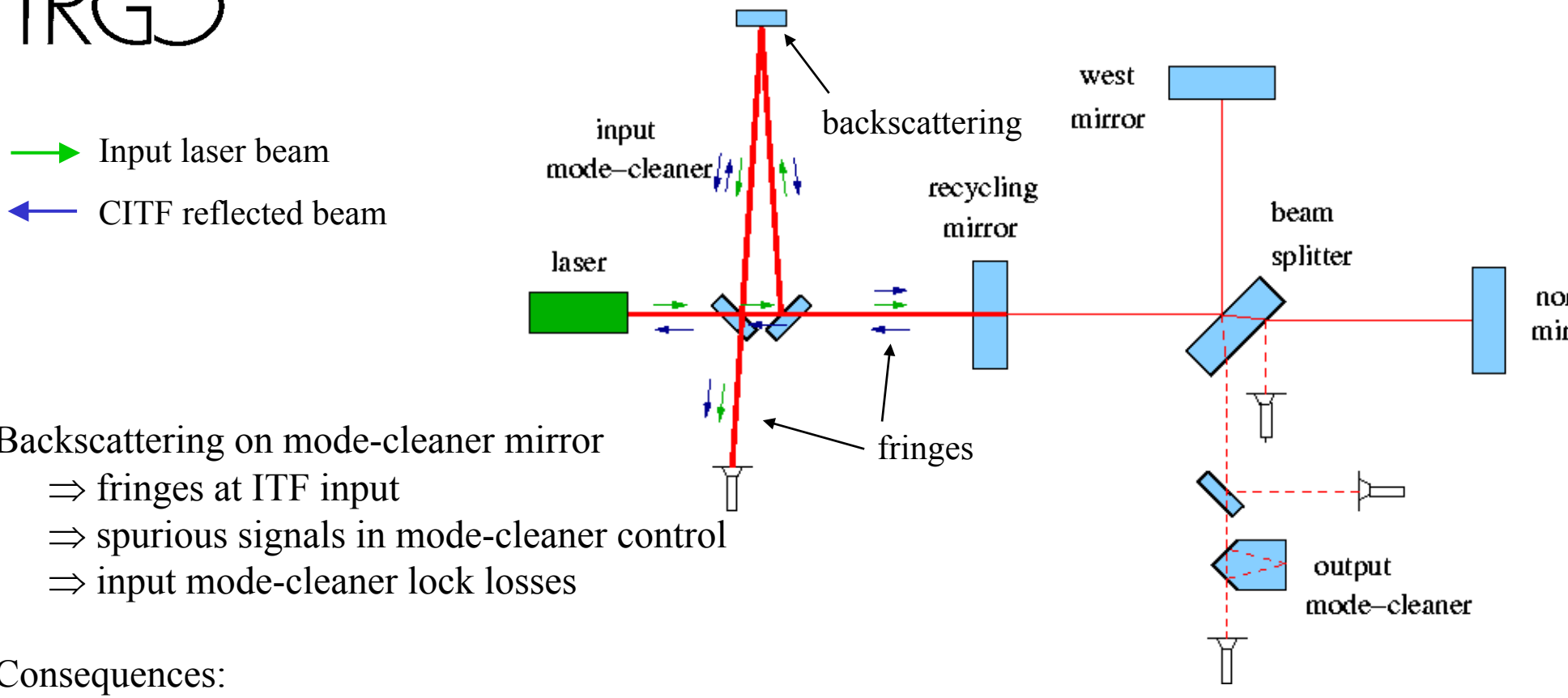
Run	Duty cycle	Longest lock (h)
E0	98%	51
E1	85%	27
E2	98%	41
E3	96%	40
E4	77%	15

- Main cause of lock losses:
  control software failures
  ⇓
  Improvement in global control in progress

Cause of lock losses	# Lock losses: E0+E1+E2+E3+E4 = Tot (%)
Operator activity	2 + 1 + 1 + 0 + 1 = 5 (28%)
Hardware failures	0 + 1 + 1 + 0 + 0 = 2 (11%)
Control system failures	1 + 0 + 2 + 1 + 3 = 7 (39%)
Feedback tuning	0 + 0 + 0 + 3 + 1 = 4 (22%)

- Smaller duty cycle during E4: backscatter in IMC

E4 Reliability (3/3)



- Backscattering on mode-cleaner mirror
  - ⇒ fringes at ITF input
  - ⇒ spurious signals in mode-cleaner control
  - ⇒ input mode-cleaner lock losses

- Consequences:
  - need to misalign recycling mirror
    - ⇒ reduction of recycling gain
  - lock acquisition longer
    - ⇒ smaller duty cycle

- Possible solutions: 1) use of Faraday isolator

  2) better mode-cleaner mirror

Solution 2) adopted so far, together with larger sidebands separation

What we learned

All functions demonstrated to work,
almost within Virgo specifications,
High reliability.

To be fixed:

- Input Mode Cleaner:
  - back scatter of light
  - low transmission / mirror pollution
  - new suspension for the far end mirror
- Control:
  - automatic lock acquisition
  - second stage of frequency stabilization
  - close more loops on automatic alignment
  - better mirror local damping required
  - suspension monitoring
  - global control software improved

Conclusions

Mirror suspension and control	
Inertial Damping	rms ~ 1 um
Long passive suspensions	Attenuation $<6.10^{-8}$ (H), $< 10^{-8}$ (V) @ 4 Hz
Suspension last stage – marionetta – reference mass	hierarchical control
Local control – position memories	precision < 1 μrad
Injection System	reliable high power system
Signal Detection	monolithic output mode cleaner
Environment monitoring and data acquisition	analysis of couplings – 4 Mb/s
Interferometer control	Fsamp = 10 kHz
lock acquisition	optical damping
automatic alignment	lock of 2 degrees of freedom
Vacuum	ok
Electronics and Software	Collects and provides data efficientl
	All digital loops.