SETTING THE STAGE
GWADW 2016

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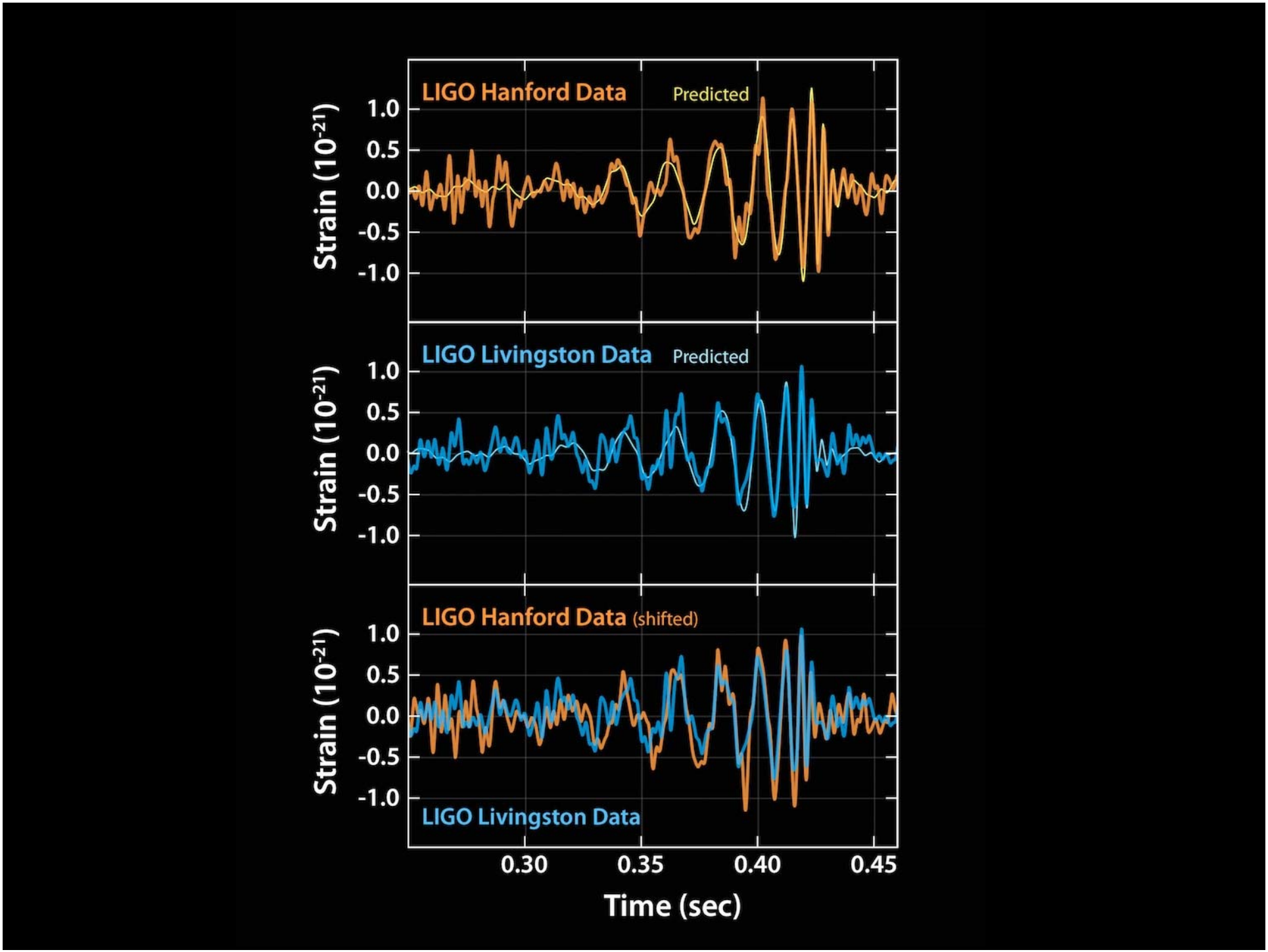
Detection of GW150914

Well deserved achievement of decades' effort

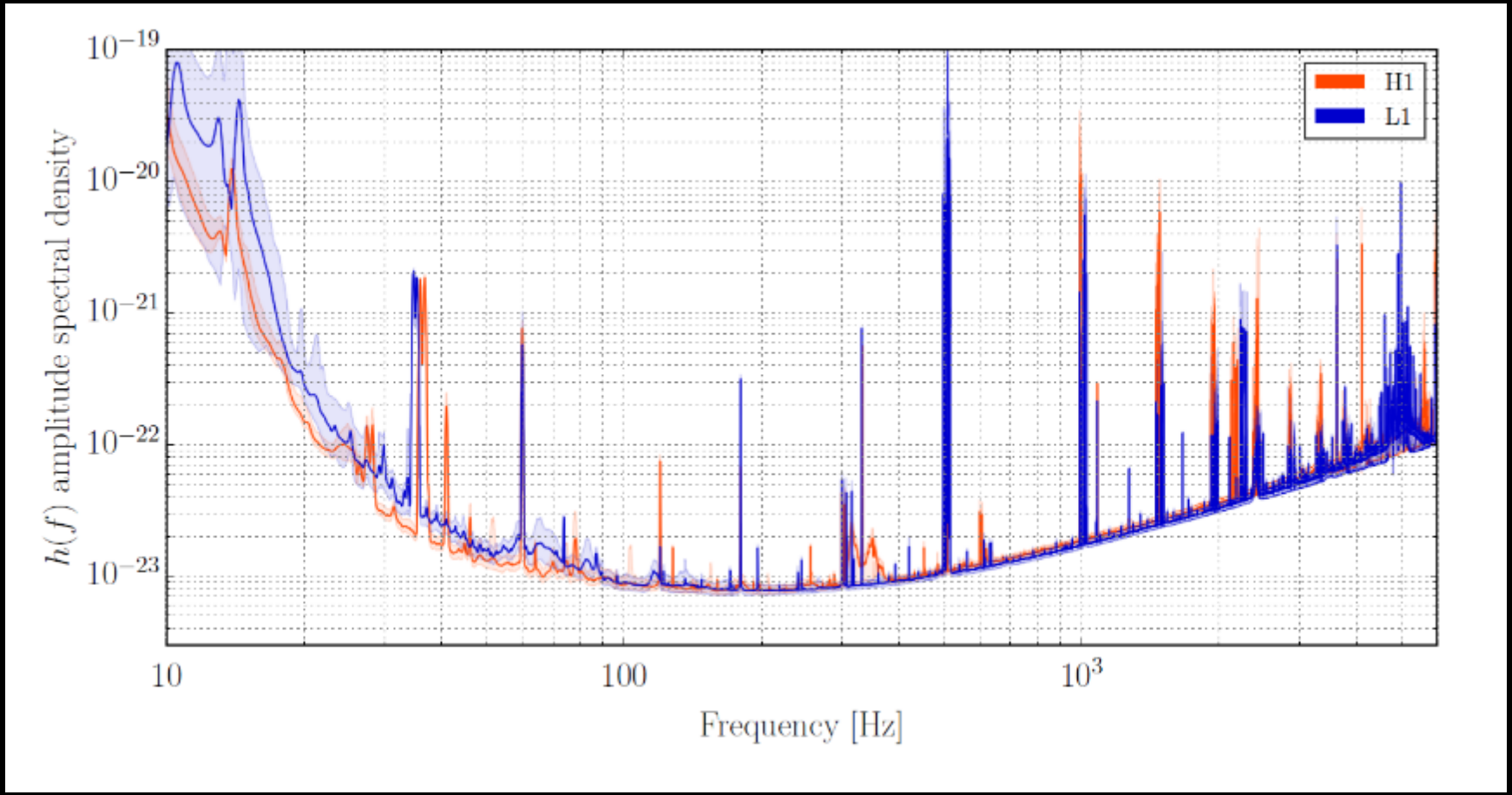
Not exactly what one expected for a first detection

Confidence in detector design and performance

As well as in the human factor around the detectors


LIGO Hanford Data
Predicted
LIGO Livingston Data
Predicted
LIGO Hanford Data (shifted)
LIGO Livingston Data
Strain (10-21)
1.0
0.5
0.0
-0.5
-1.0
0.30
0.35
0.40
0.45
Time (sec)

Interferometer performance



average measured strain-equivalent noise, of the Advanced LIGO detectors during Sept 12 - Oct 20, 2015

Enormous progress made from LIGO to aLIGO

Overall sensitivity level:

Definitely below 10^{-23} $Hz^{-1/2}$ around 200Hz

Clean spectrum:

60Hz and harmonics dominating

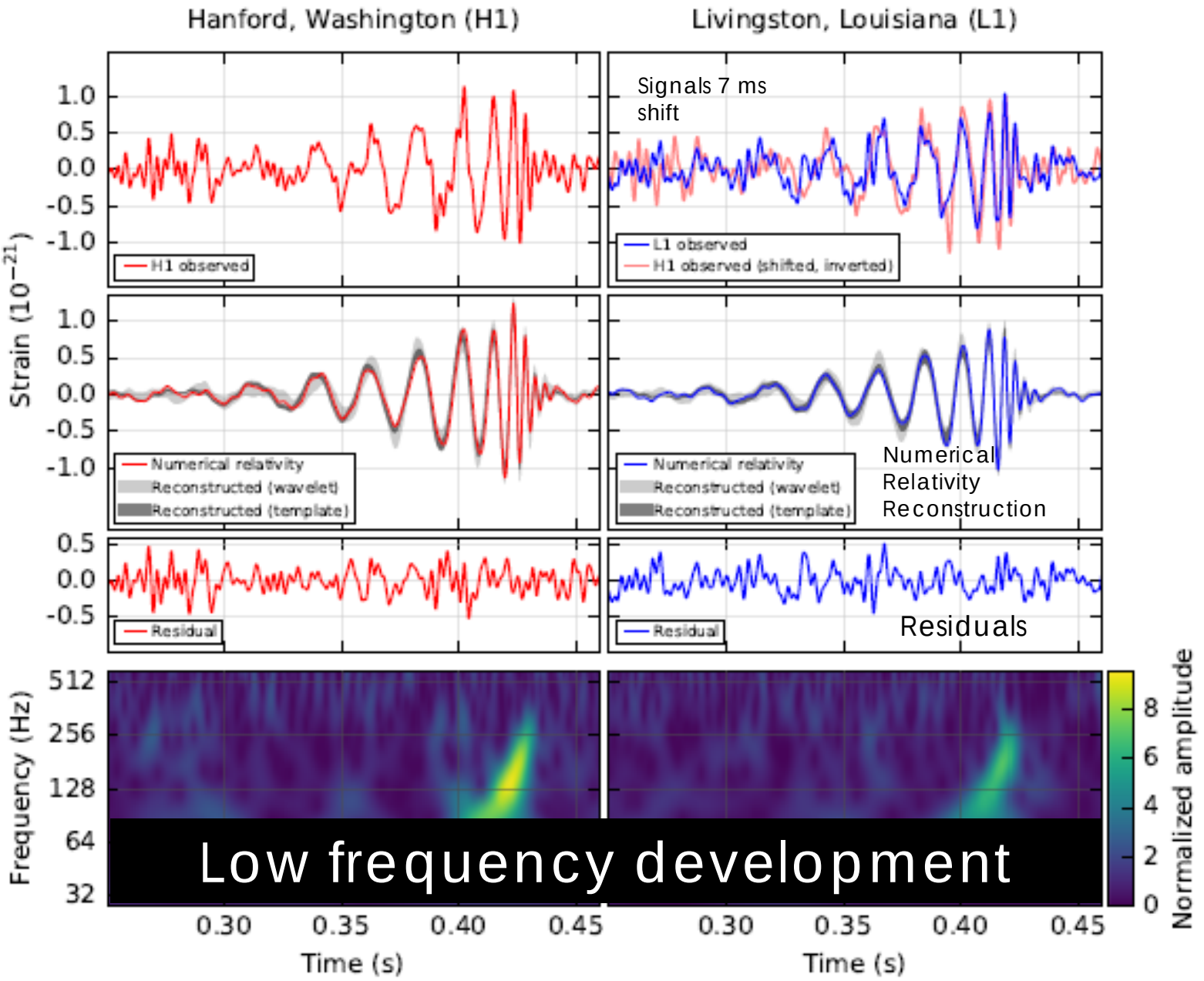
Few more structures present

Excess noise below 30 Hz

Noise stationarity very good, worse at low freqency

Km scale interferometers are understood over a very large fraction of the useful spectrum

GW 150914 Signals



Improvement lines: Controls workshop

Low frequency

Since 2015 GWADW has a strong focus on control

Moving:

- from primary requirements for lock acquisition and stability
- to more refined techniques that work on several degrees of freedom

In order to:

- give robustness with respect to environment changes
- limit low frequency noise coming from large ouf of band noise

Allowed by:

- having more sensors for more state coordinates
- going digital
- a large real time computing power
- an improved simulation

Applications

Improvement lines: Thermal noise and coatings workshop

- Limitation by thermal noise in most of the spectrum
- In presence of excellent bulk mirror mechanical properties, coatings spoil thermal noise performance
- Amorphous coatings:
  - Atomic structure understanding
  - Modeling
  - Measurements
  - New materials
- Crystalline coatings
- Applications

Improvement lines: low frequency

- Newtonian noise minimization and subtraction:
  - Mass distribution aroung test masses and newtonian noise modeling
  - Sensor types: translation and rotation
  - Sensor distribution
- Atom fountains
- Torsion bar
- Gyrolasers
- Applications: oil prospection

Improvement lines: interferometer configurations

- Optical configurations
- Atomic interferometry
- «Squeezing is a solved problem»
  - Can be improved
  - Needs to be frequency dependent
  - Other wavelengths to be considered
- Applications

Improvement lines: cryogeny

CLIO, then KAGRA experience

Progress toward 120 K and 20 K

Applications

Interferometer development

The path for the next 12 years of the second generation

Third generation

Global view and coordination

Experimental challenges

Applications

Space detectors

- Lisa Pathfinder launch
  - Scientific operation
- Lisa
  - Strengthen the effort
  - Consequences of having detected first a BBH with somewhat unexpected mass
  - Toward a review of launch date?

- Applications

Gravitational wave physics

- Lessons from GW150914
  - Information value of those waveforms
  - Rates of sources
  - Detector networks
  - Multimessenger astronomy
- Applications

GWADW 2016 workshop

Setting up the program was most stimulating
Many energies are being unleashed
Many more brains are joining the effort

This edition of GWADW is well set to mark the begin of a new era in detector development

What appears to the outsider as leisure time is intense brain work with most unexpected outcome

Be prepared!

Thanks !