Presentation of the interferometer division

J. Degallaix and S. Hild
who/what is in this division?

• 2 co-chairs: J. Degallaix and S. Hild
• 6 work packages:
  ▷ Observatory design and noise budget
  ▷ Optical layout, sensing and control scheme LF
  ▷ Optical layout, sensing and control scheme HF
  ▷ Data acquisition and real time control
  ▷ Noise characterisation
  ▷ Calibration

For each WP, one chair and one deputy

(for the global context see A. Freise presentations ET-0073A-20 and ET-0075A-20)
Observatory design and noise budget

- **Scope:**
  - development and updating of theoretical noise budgets
  - acting as interface to the science case
  - optimisation (T, filtering cavities, frequency cross over)
  - prepare scenarii for trade-off

Work already started with a development of a new version of PyGwinc (**ET-0067B-20**).
Reminder of the sensitivity goal

Comparison with 2G detectors
The geometry of the detectors

- 3 detectors arranged in triangle.
- Each detector is 2 interferometers

from: ET-0073A-20
Observatory design and noise budget

The combined sensitivity curves:

Curves reproduced with PyGwinc
Noise budget low frequency

- $T = 10 \text{ K}$
- silicon test mass
- $\lambda = 1550 \text{ nm}$
- $P_{\text{input}} = 3 \text{ W}, P_{\text{arm}} = 18 \text{ kW}$
- 9 dB squeezing

Work in progress
Noise budget high frequency

- $T = 290 \, \text{K}$
- fused silica test mass
- $\lambda = 1064 \, \text{nm}$
- $P_{\text{input}} = 500\,\text{W}$, $P_{\text{arm}} = 3 \, \text{MW}$
- 10 dB squeezing
- (now) TEM$_{00}$

Work in progress
Optical layout, sensing and control scheme LF/HF

• Scope:
  ▶ development of optical layout of core interferometers
  ▶ main large optics specifications
  ▶ define locking scheme
  ▶ define LSC\(^1\) and ASC\(^2\) strategies

Similar works for the 2 WPs with a lot of common tools/procedures. However important differences also exists:
• LF: emphasis on low frequency
• HF: taking care of the very high power

\(^1\) Length Sensing Control \quad \(^2\) Alignment Sensing Control
Optical layout, sensing and control scheme LF/HF

Recent progress about the recycling cavities design:

More tomorrow afternoon and on arXiv
Data acquisition and real time control

• Scope:
  ▶ requirements for the control and data acquisition systems
  ▶ choice of the timing distribution network
  ▶ preliminary budget for the hardware cost

Close interaction with the ET pathfinder (and Virgo upgrade?)
Data acquisition and real time control

- More specific questions to be answered:
  - hardware architecture choice (Virgo vs LIGO vs commercial)
  - estimation of data flux for DAQs, real time control
  - DAQs software management / data access
  - investigation digital vs analog demodulation
  - specifications for online software, automation, latency

Essential input from other WPs
Noise characterisation

- New WP following the lessons learned from 1G and 2G
- A transverse package to ease the commissioning and all the future noise investigation

Scope:
- review the other WPs from the point of view of noise characterisation
- derive a list of noise for the technical noise budget
- proposed a strategy to project those noises
- also essential for glitch investigation and vetoes
Noise characterisation

What you want... and what you got

Making sure we will know the level of all the pertinent noises
Calibration

From the output of my detector to the dimensionless amplitude of the GW signals

• Scope :
  ▶ calibration requirements (derived from science goals)
  ▶ development of optimal recombination, null-stream
  ▶ design the calibration strategy and relevant hardware
  ▶ cost estimate
Calibration

- Estimated accuracy requirement:
  - amplitude errors < 0.5%
  - phase errors < 0.1 rad
- 2 ways: photon calibrator (with a laser beam) vs. Newtonian calibrator (with rotating masses)

Implemented already in 2G detectors
Conclusion

• Chance to design a new observatory
• A long road ahead... with extensive experiences from 2G
• Most urgent work: the tunnel configuration
• Everyone is welcomed to contribute, plenty of tasks within the different WPs

Would you like to participate?

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