The View from Europe

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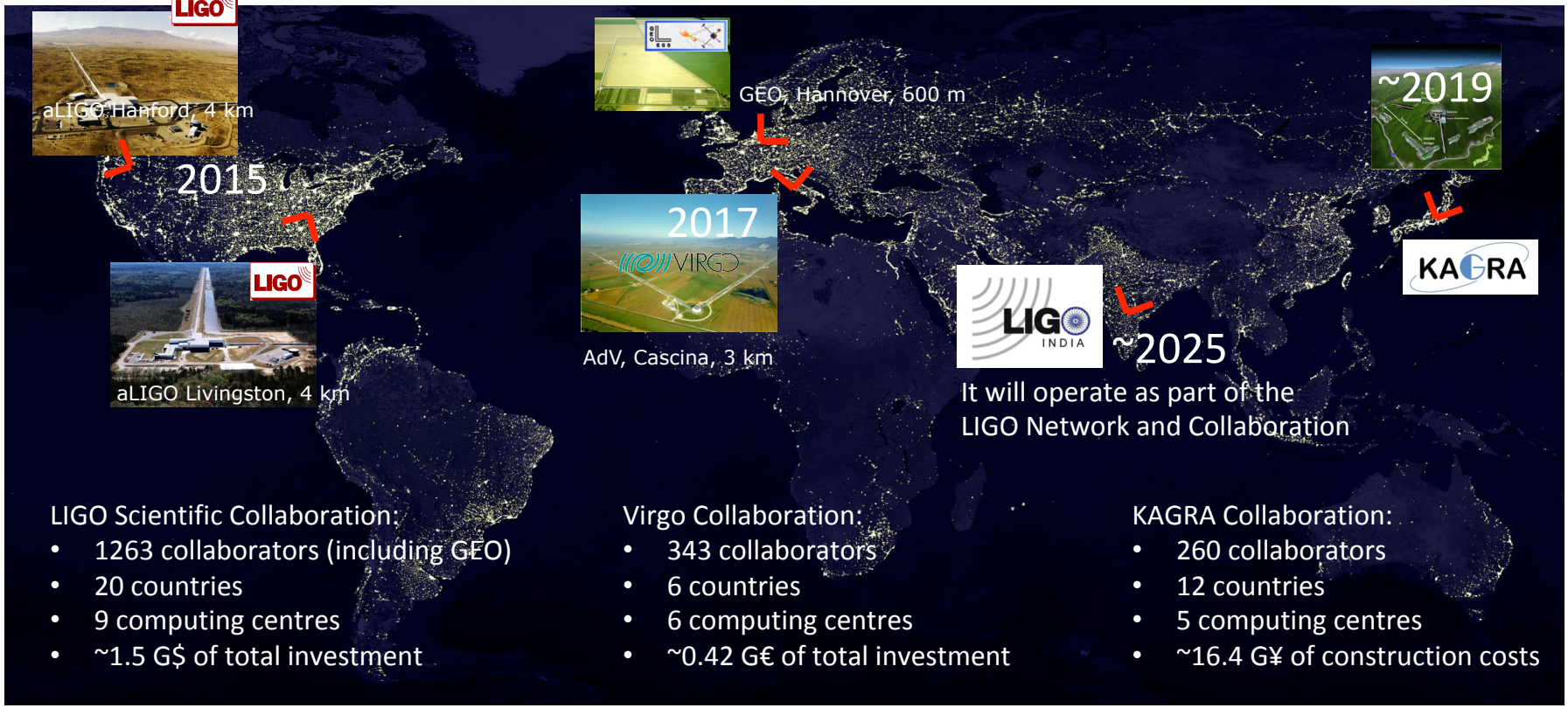
Gravitational Wave Physics in Europe



1. *GW: GEO, Virgo , LIGO , LISA*
2. *Other Large Infrastructures in the field : LOFAR/SKA, CTA, KM3NET/ICECUBE*

- *I will concentrate here on EGO/Virgo developments with large impact of GEO colleagues on technology (squeezing) and 3G leadership*

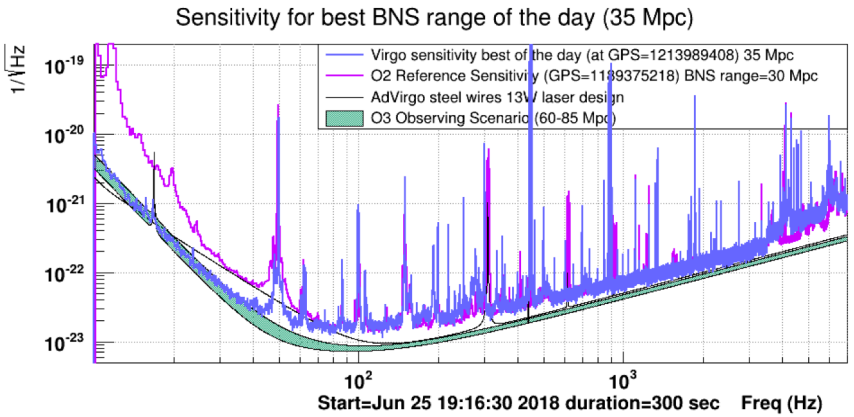
30 years of EGO/Virgo History

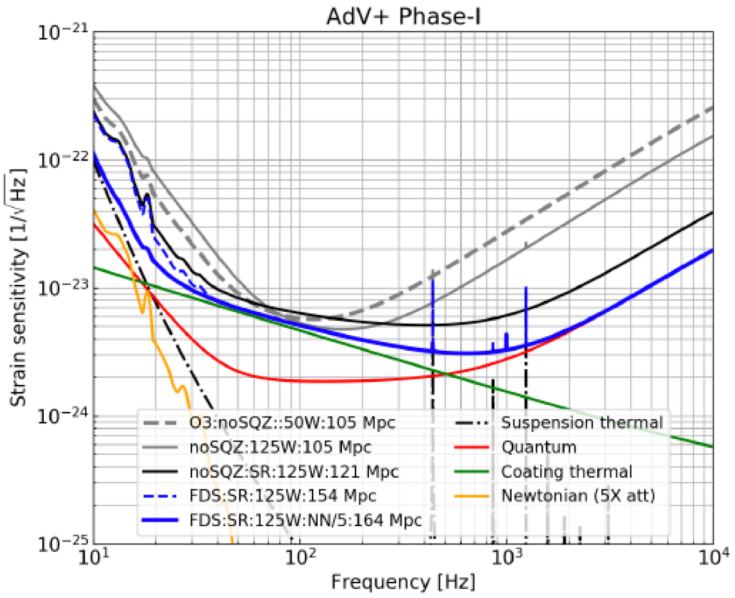
- **Virgo**
- **1989** Virgo proposal
- **1993-1994** CNRS and INFN approve VIRGO (+5y)
- **1997** Construction starts near Pisa (+7y)
- **2000** Foundation of EGO (CNRS, INFN) (+11y)
- **2003** Inauguration of VIRGO (+14y)
- **2004-2006** Commissioning of VIRGO
- **2006** Netherlands joins EGO as an Observer
- **2007** Start of Virgo science runs (+18y)
- **2007** LIGO-VIRGO "a single machine"
- **AdVirgo**
- **2009** EGO Council approves AdVIRGO (+20y)
- **2010** Polish, Hungarian and Spanish groups join AdVirgo
- **2017** Enters in operation (+8y, +28y)
- **2019** O3 RUN BNS each 60-85 Mpc (+10y,+30y)

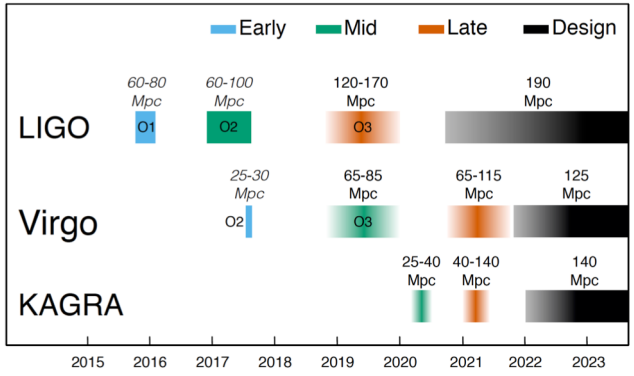
– **Total cost (US costing, including HR) near 0.5 BE**

The next 5 years

- **2019 O3 Run**
- **Range BNS >60 Mpc (BBH x10)**
- **Events BNS 0(9) , BH-BH 0(35)**
  (Uncertainly factors of 3-5)
  - **Monolithic suspensions, 70 to 100 W**
  - **Frequency Independent Squeezing (AEI**
- **Adv+ Phase I**
- **2024 O4 Run Range BNS >120 Mpc**
  - **Complete AdV: Signal recycling**
  - **Frequency Dependent Sqeezing (➔ 150 Mpc)**
  - **Newtonian Noise Cancellation (➔ 160 Mpc)**
  - **Events x 10**
  - **Cost 0(10 M€)**



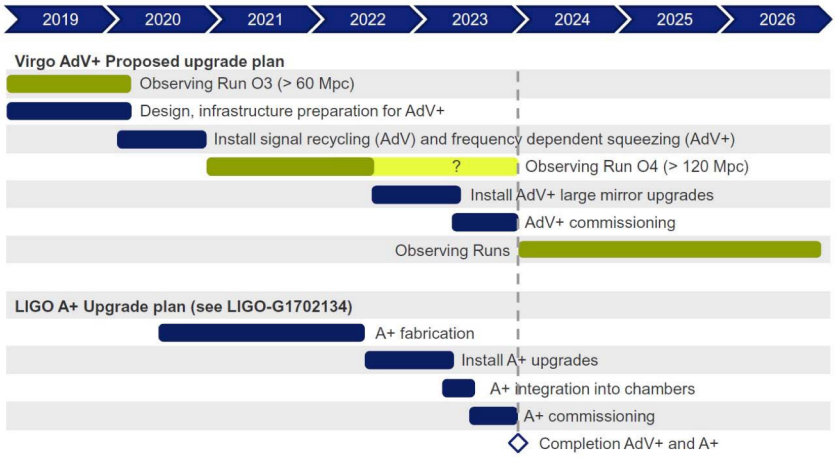


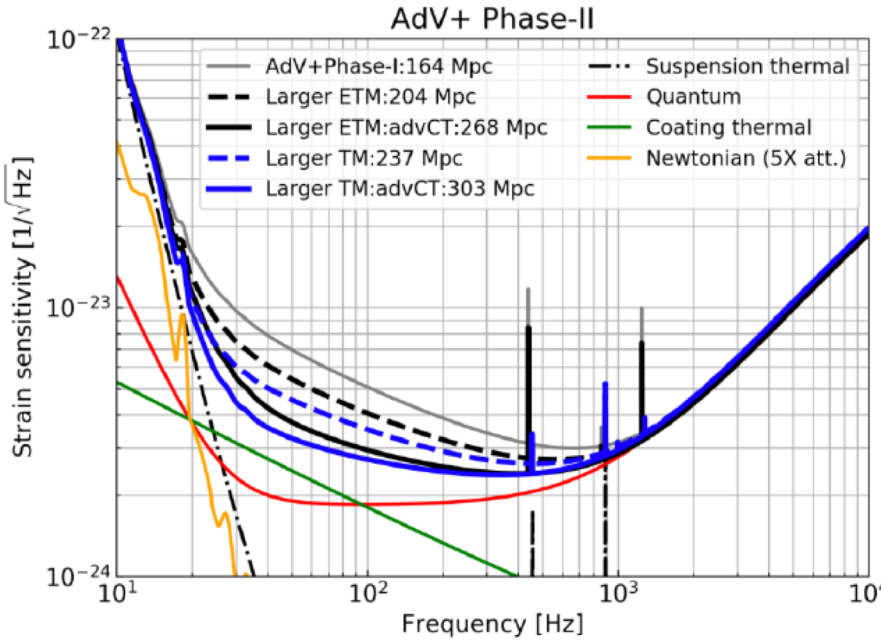


The next 10 years (ca 2030)

- **AdV+ Phase II**
- **O4 duration not determined yet**
- **Towards the end of decade O5 Run**
- **Larger beam, increase test masses**
  - **Range 200-230 Mpc**
- **Better coating (x3)**
  - **Range 260-300 Mpc**
- **Sensitivity increase x10 w.r.t. today**
- **Cost 0(20-30 M€)**

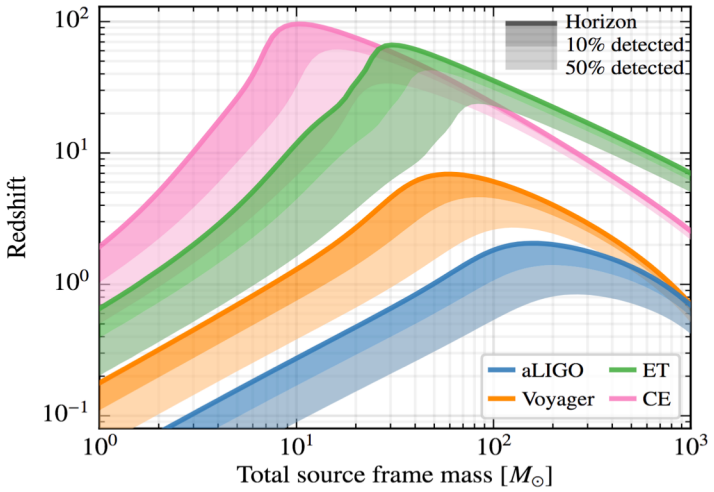
- **Challenges:**
  - **Grand Coater upgrade**
  - **Vacuum infrastructure**
  - **Payloads and attenuators**
  - **Aberration control**



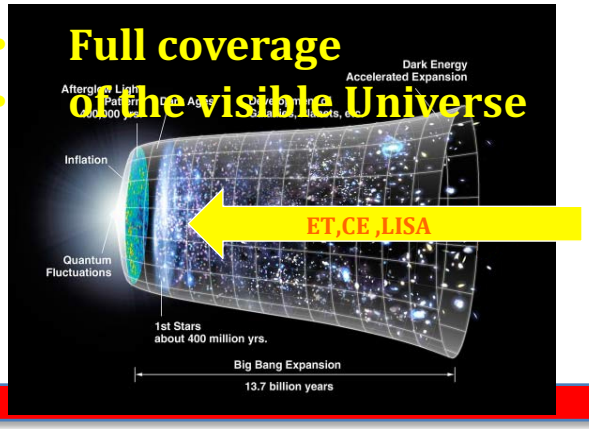


The next 25 years
3G : Einstein Telescope

- ET History
- 2004 Idea(FP6-Ilias project, EU)
- 2008-2011 Design Study (FP7, EU) Fr, De,, It, NL, UK coordinated by EGO
- 2012-2018 Further studies: Elite, Grawiton (FP8 or H2020, APPEC)
- 2018 Founding workshop: Formation of ET Collaboration
- 3 sites (North, South, East of Europe)
- Proposed scenario:
- 2021-2022 Site selection`
- 2023 TDR
  - 2G➔ 3G Sensitivity x10 , Cost 0(1-2 B€)
- 2025 Start excavation
- 2030-2031 End of civil infrastructure
- 2032+ Installation, Comissioning, Operation (2034 Lisa launch)



- Full coverage
- of the visible Universe



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Institutional markers in the next 5 years

- **Before the end of 2018**
  - AdV+ hopefully phase I approval (Sep 29, Dec 15)
  - Participation of GW to the CERN European Strategy document
- **Before the end of 2019**
  - September: submission of a proposal that the path ***AdV+ Phase II ➔ ET*** is included in the ESFRI Roadmap (publication date 2020). Crucial for European country acceptance.
  - Extension of the EGO consortium: in time (2020-2025) and in space (Netherlands +)
- **Before the end of 2021**
  - Approval of AdV+ phase II
- **Before the end of 2023**
  - Approval of ET construction

Strengths and opportunities of the process (a personal view I)

- **Science**
  - It is a field where there is rare continuity between observation, upgrade and design of a new infrastructure
  - The global network enhances the science potential. ET and CE are embedded in a global process and the GW community up to now has shown an exceptional unity in these matters.
  - GW address many fields of fundamental science: from Astrophysics and Cosmology to Particle and Nuclear Physics but also and photonic/optomechanics challenges.
- **Technology, Industry and Society**
  - AdV+ Phase II will permit to tackle the technological risks of ET (de-risking)
  - The interlinked sensor network monitoring and mitigating noise of the interferometers is at the avant-garde of the technological front of "smart infrastructures"
  - The environmental studies can become a source of innovation in geological and atmospheric matters (early warnings, earth, cloud and sea monitoring). Synergies.
  - The 3G civil-infrastructure is a large part (>90%) of the cost, there are technological, innovation synergies to be developed with other fields (HEP , ν) with the same concerns of civil infrastructure
  - GW Computing is also at the forefont of recent developments (big data analytics, machine learning,..)
  - There is a huge potential of outreach and education accompanying the GW revolution

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Possible threats and a list of actions (a personal view II)

- **There is always the danger to mix time and space scales.**
- *In time*, when the present (2G and 2G+) harms the potentialities of the future (3G) or 'sin of rémanence' , but also vice-versa where a precipitation of the future (3G) harms the rich potential of the current upgrades "sin of impatience"
- *In space*, if the regional initiatives advance without coordination with the global effort. Here GWIC, GWAC, DAWN but also APPEC, ASTRONET etc play a crucial role
- **Possible actions increasing the possibilities of success**
- Strengthen the ties with the Multi-messenger community worldwide and increase the links with the Cosmology, HEP and and Nuclear ones as well as the interdisciplinary ties with Geoscience community at a regional and global level.
- Launch common R&D and Computing initiatives
- Develop the synergies on the issues of smart and innovative civil infrastructures
- Exchange on the designs and governance schemes (GWIC-3G) and collaborate on roadmapping exercises
- Develop a common outreach and education plan ?

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Thanks