

The View from Europe

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30 August 2018

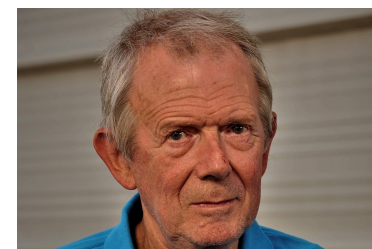


1. GW: GEO, Virgo, LIGO, LISA
2. Other Large Infrastructures in the field : LOFAR/SKA, CTA, KM3NET/ICECUBE

- 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 reach 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)

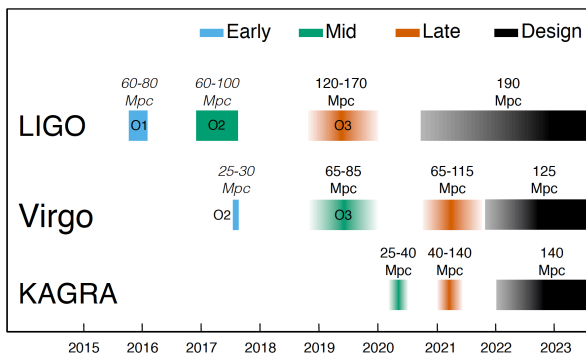
(Uncertainly factors of 3-5)

- Monolithic suspensions, 70 to 100 W
- Frequency Independent Squeezing (AEI)

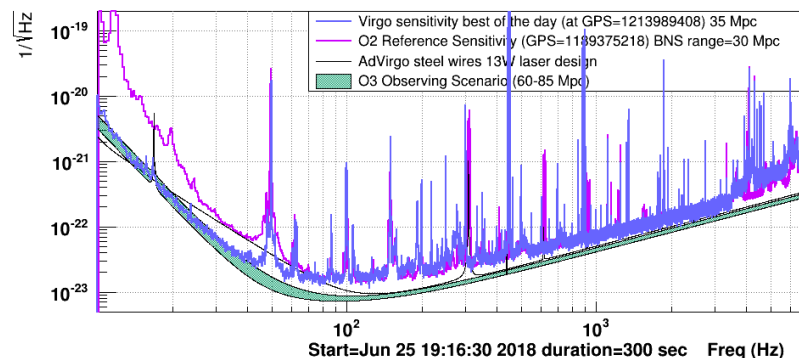
Adv+ Phase I

2022-2024 O4 Run Range BNS >120 Mpc

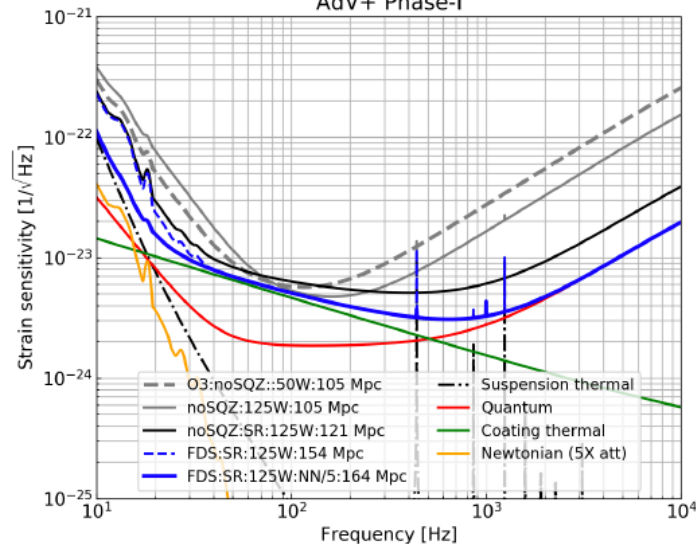
- Complete Adv: Signal recycling
- Frequency Dependent Squeezing (→ 150 Mpc)
- Newtonian Noise Cancellation (→ 160 Mpc)
- Events x 10
- Cost 0(10 M



Sensitivity for best BNS range of the day (35 Mpc)

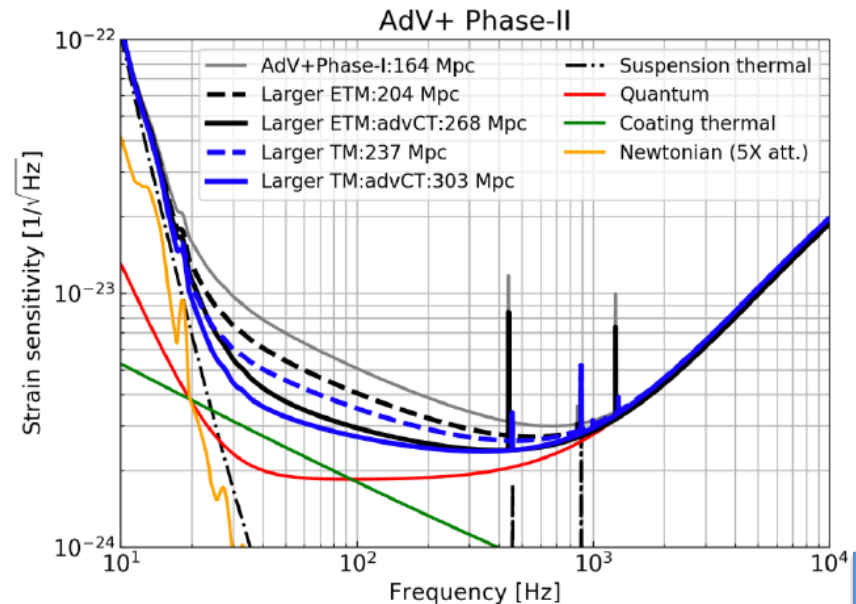
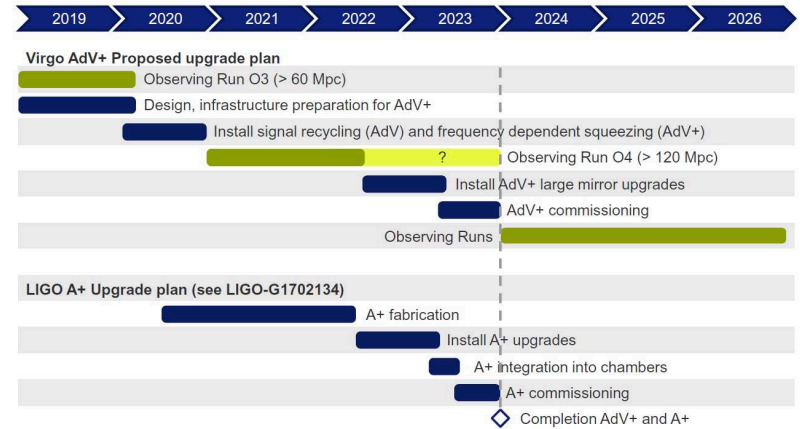


AdV+ Phase-I



The next 10 years

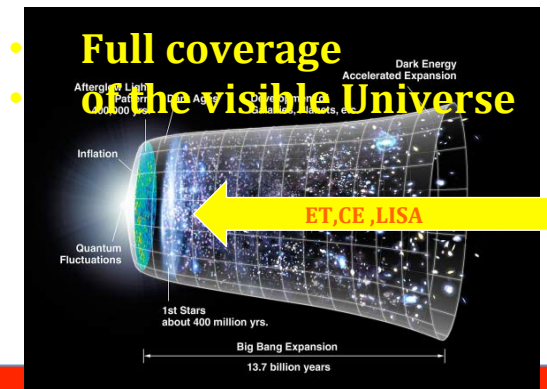
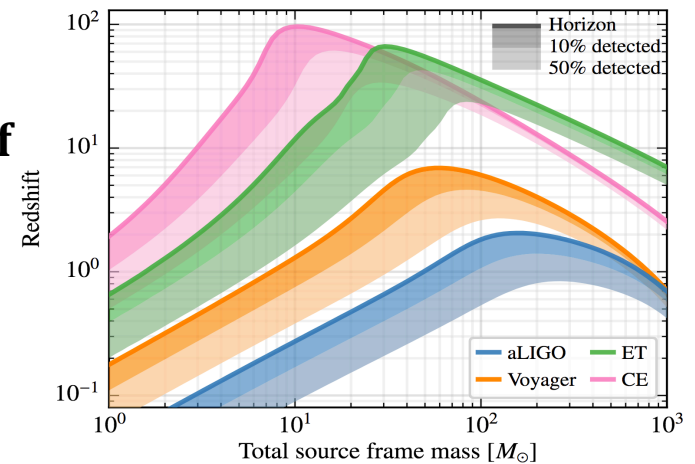
- **AdV+ Phase II**
- **O4 duration not determined yet**
- **> 2026 O5 Run**
- **Larger beam, increase test masses**
 - Range 200-230 Mpc
- **Better coating (x3)**
 - Range 260-300 Mpc
- **Sensitivity increase x10 w.r.t. today**
- **Cost 0(20-30 M€)**
- **Challenges:**
 - Grand Coater upgrade
 - Vacuum 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, Commissioning, Operation (2034 Lisa launch)



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 forefront of recent developments (big data analytics, machine learning,..)
- There is a huge potential of outreach and education accompanying the GW revolution

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 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 ?