

# Addendum to the GW-ET3G contribution to the European Particle Strategy

The additional elements described by this addendum are:

- Interested scientific communities
- Timeline
- Construction costs

## Interested Communities

For more than a decade, the European gravitational wave (GW) scientific community has been studying the possible evolution of current detectors (known as "advanced" or second generation) towards a new generation (the third) capable of studying a volume of the universe that is 1000 times larger than the current generation (at design sensitivity). European scientists have driven this study forward in a concept study funded by the European Commission in FP7 that led to the Einstein Telescope project (<http://www.et-gw.eu/>). A scientific community has grown around the Einstein telescope project, including the vast majority of the Virgo and the GEO collaborations (the GW detectors currently operating in Europe), but it goes beyond that and involves more than 660 scientists who have currently signed the Einstein telescope letter of intent (<http://www.et-gw.eu/index.php/letter-of-intent/et-loi-results>). The Einstein telescope project is currently represented in the Gravitational Wave International Committee (GWIC) Roadmap, the APPEC Roadmap, some national roadmaps in Europe and will be submitted at the next update of the ESFRI Roadmap.

The detections by the GW interferometers, the LIGO detectors in the USA and the Virgo detector in Europe, the great scientific impact on the astrophysical and fundamental field of physics, the Nobel Prize for Physics 2017, have boosted interest in the third generation worldwide. In Europe, three sites were candidates for hosting the ET infrastructure (Italy, Hungary and over the borders between the Netherlands, Belgium and Germany), and part of the funding for this candidature was provided by national governments (Italy and the Netherlands). In the US, the idea of a third-generation GW observatory is converging in a project called Cosmic Explorer (CE), whose conceptual design was funded by NSF in 2018.

Since gravitational wave research fosters cooperation rather than competition, the GWIC has organised a global coordination effort and set up a specific subcommittee to deal with the harmonisation of third-generation activities (GWIC-3G).

The communities interested in this contribution go beyond the global gravitational wave community:

- Astronomical and astrophysical communities are strongly interested in the multi-messenger capabilities of the global network of 3G observatories; our partners are the electromagnetic and neutrino telescope communities that complement the observation of the GW source
- 3G GW Observatories are a unique laboratory for the study of General Relativity and alternative theories of gravity. The theoretical physics community working on these aspects of basic physics research is very interested in the potential of 3G detectors, as underlined by the large presence of scientists from these communities in the ET project.

The list of people that participated to the preparation of the main document and that are supporting it is available here:

<https://docs.google.com/spreadsheets/d/1oyLCtosZMPixVsODjJ3-UpkfkUMP7mEQzaawlctU1PU/edit#gid=0>

## Timeline

In GW monitoring, it is of fundamental importance to keep the interferometers in the global network at a conformal sensitivity level. For this reason, Advanced LIGO and Advanced Virgo, as shown in Figure 1, have a parallel program of upgrades that enables them to take full advantage of the existing infrastructure. 3G detectors will continue these developments in new infrastructures that allow a jump of a factor of 1000 in the volume of the observed universe.

The Einstein telescope has a well-defined roadmap which has been shown in Figure 2 from the beginning of its history.

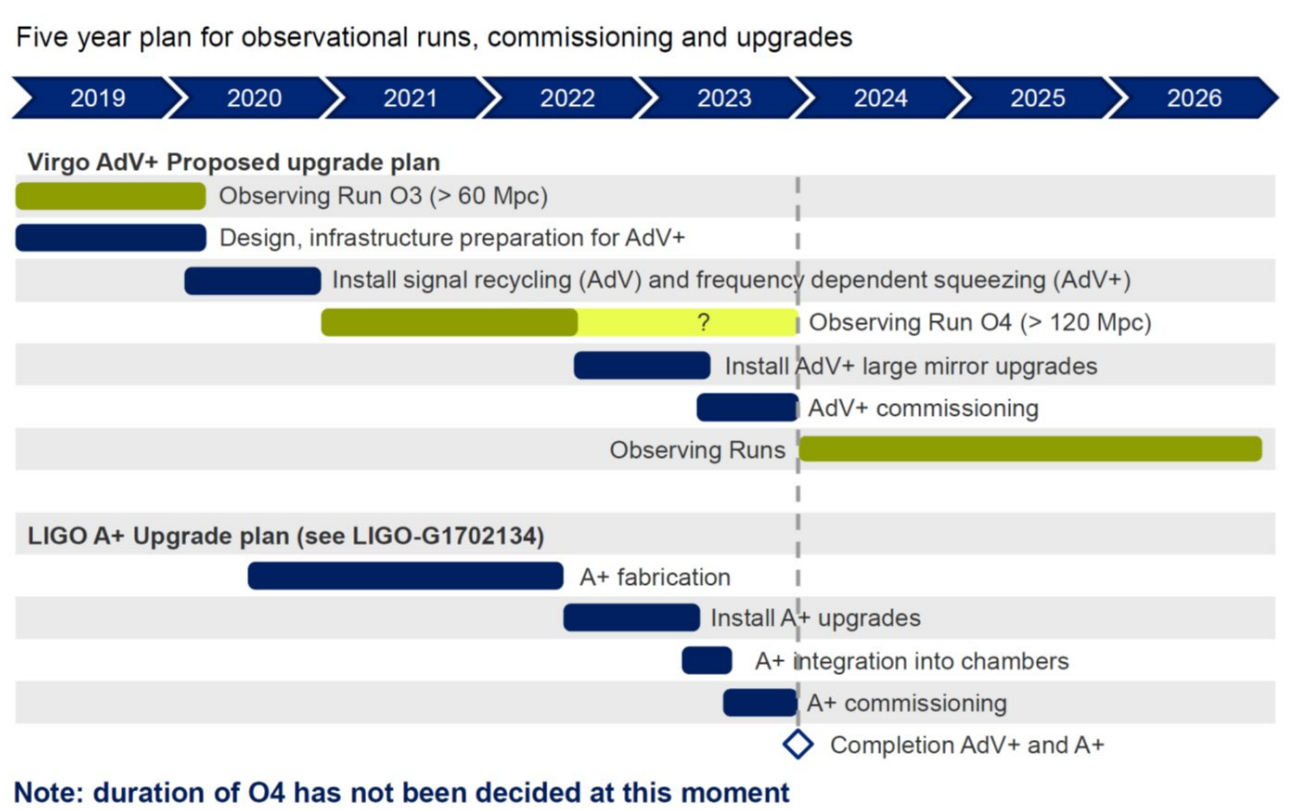


Figure 1- Evolution of the Advanced detectors in the next 8 years. Since LIGO and Virgo (and after 2020 KAGRA) will have scientific data taking in parallel, the scientific runs (green bars) are shown just once.

## Costs Definition

The definition of ET costs is an iterative process; the first assessment of the costs was made in the Concept Report (CDR - <http://www.et-gw.eu/index.php/etdsdocument>), which classified ET as a Class 1G€ research infrastructure. The current iteration for a more refined cost assessment will be completed when the proposal for the ESFRI Roadmap (2020) is submitted. As shown in Figure 2, two tasks that are fundamental to the precise definition of ET costs are progressing in parallel: site qualification/decision and technical design. As soon as the site hosting ET is selected, the largest uncertainty in the excavation costs is constrained (2022) and finally, when the technical design report (TDR) is realised and the latest design options are frozen, the

final cost of the observatory will be fully defined.

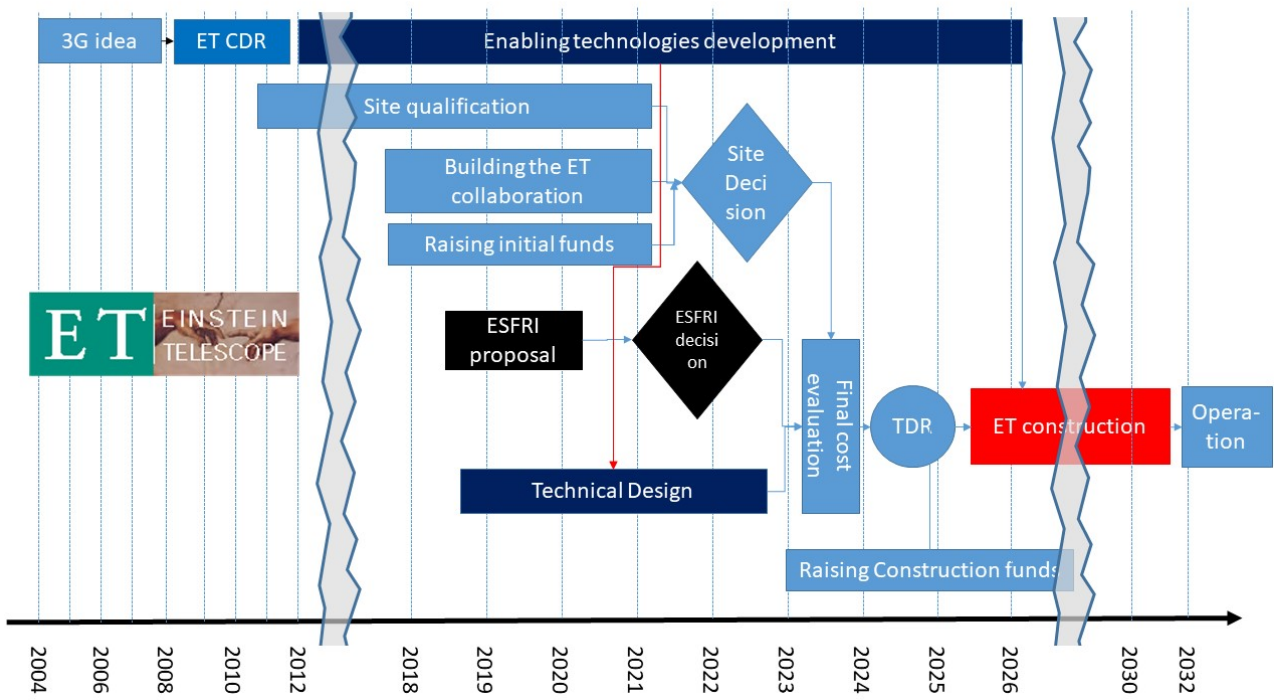


Figure 2- ET roadmap