Present and Future GW detectors

Michele Punturo

INFN Perugia

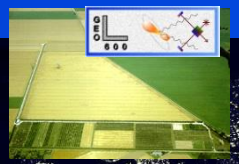
Terrestrial Detectors

Advanced detectors 2015-2025

Data exchange:
aGWD network!

aLIGO Hanford, 4 km

GEO, Hannover, 600 m



~2018

~2022

AdV, Cascina, 3 km

aLIGO Livingston, 4 km

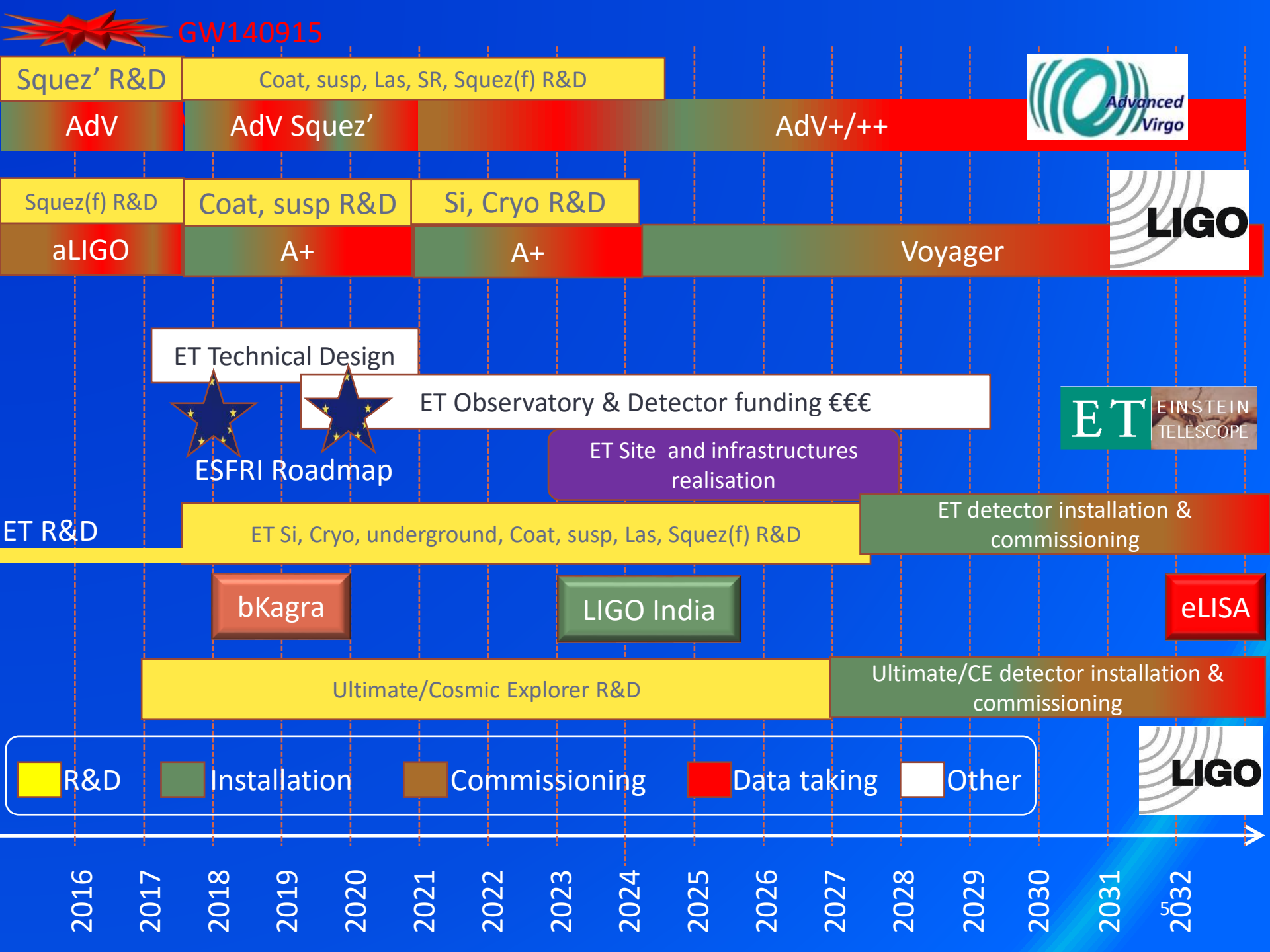
LIGO INDIA

Limits of the current infrastructures

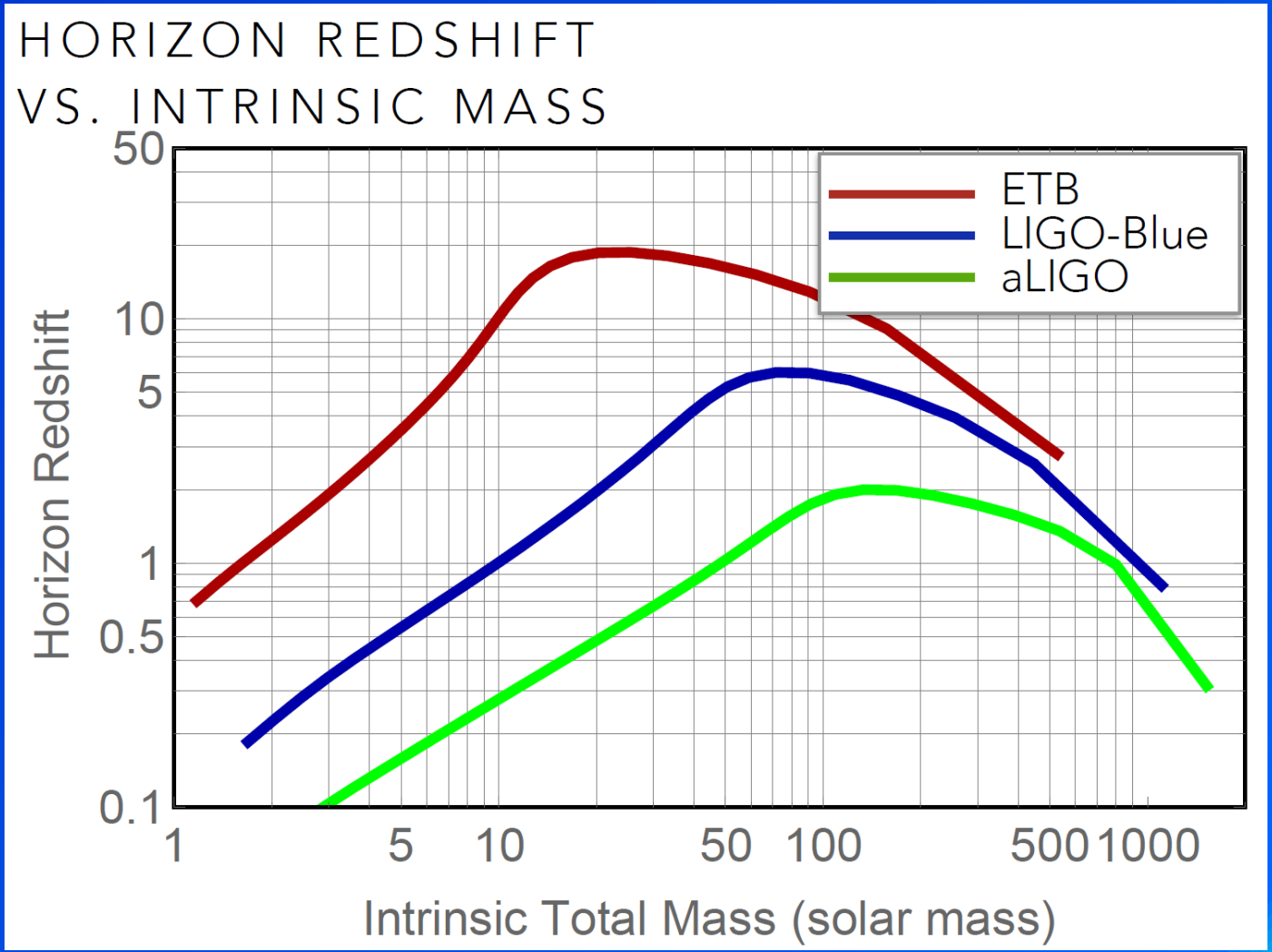
- LIGO infrastructure has been completed at the end of 90s, Virgo infrastructure in 2003
- The sensitivity of the Advanced detectors will be limited by the detector technologies, but the limits of the infrastructures aren't too far:
  - Obsolescence
  - Length
  - Limitation to the implementation of heavy modifications to the current detectors (filter cavities, different topologies – like sagnac, different geometries)
  - Environmental noises:
    - Seismic noise
    - Cultural noises
    - Newtonian Noise
    - Wind

Evolution Plan

- A coordinated evolution plan of the advanced detectors is under definition
  - 1st phase: improvement of the detectors in the current infrastructures
  - 2nd phase: realization of 3rd generation observatories in new infrastructures


GW140915
Squez' R&D
Coat, susp, Las, SR, Squez(f) R&D
AdV
AdV Squez'
AdV+/++
Advanced Virgo
Squez(f) R&D
Coat, susp R&D
Si, Cryo R&D
aLIGO
A+
A+
Voyager
LIGO
ET Technical Design
ET Observatory & Detector funding €€€
ESFRI Roadmap
ET Site and infrastructures realisation
ET EINSTEIN TELESCOPE
ET R&D
ET Si, Cryo, underground, Coat, susp, Las, Squez(f) R&D
ET detector installation & commissioning
bKagra
LIGO India
eLISA
Ultimate/Cosmic Explorer R&D
Ultimate/CE detector installation & commissioning
R&D
Installation
Commissioning
Data taking
Other
LIGO
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032

Performances evolution (in terms of optimal horizon)



Initial comments

- Fulvio Ricci:
  - Evolution of Virgo
- Michele Punturo
  - Einstein Telescope
- Valeria Ferrari
  - Fundamental physics potential of 3G observatories and eLISA
- Marica Branchesi
  - Multimessenger in the future: how/why to complement GW observations

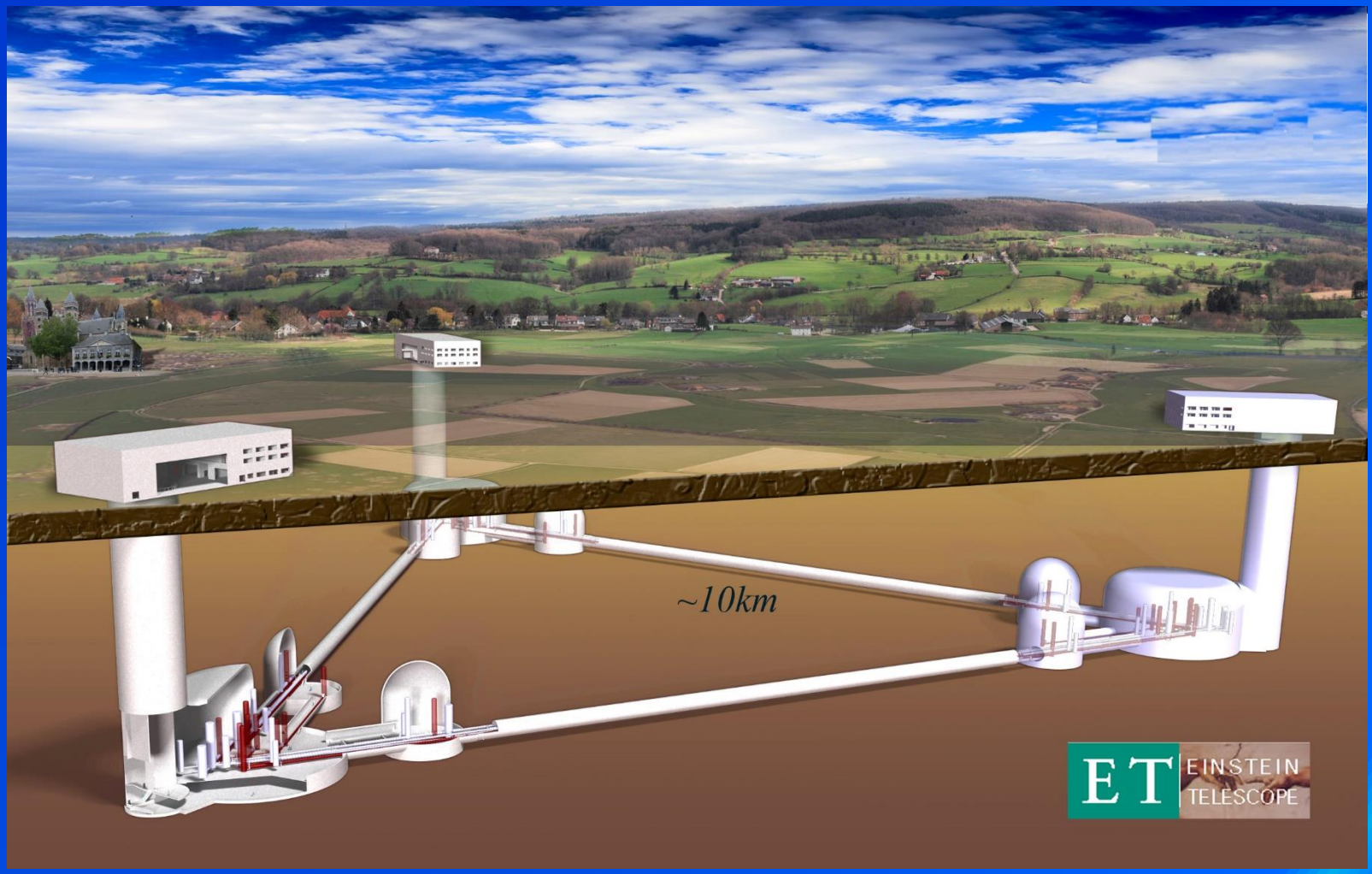
Fulvio Ricci

Evolution of Virgo

3rd Generation

- 3rd Generation GW Observatory:
  - Einstein Telescope
- Key concepts:
  - It is a research infrastructure capable to host more than one detector and, thanks to the low environmental noise, their evolutions for decades
  - Observatory:
    - Wide frequency spectrum: few Hz-10kHz
    - Factor 10 improved sensitivity wrt 2G
    - Capable to reconstruct both the polarizations
    - Some (poor) localization capability
    - High SNR for BNS and BBH signals
- Conceptual design Study delivered in 2011
  - Expected to be in operation in ~2030
- Currently are interested groups from IT, FR, NL, DE, UK, PL, HU, RU
- 3G idea now spreading also in USA: we are collaborating to define a common scenario

Einstein Telescope



eLISA

- Space based $\geq 10^6$km detector
- 3 satellites in triangular configuration in Heliocentric orbit
- Low frequency sensitivity
  - 10^{-4}-10^{-2}/10^{-1}Hz
- Target
  - Supermassive BH: 10^5-10^7Ms
- LisaPF now flying and testing the technologies

Science Targets of 3G/eLISA

- Fundamental physics targets
  - Valeria Ferrari
- Multi-messenger aspects:
  - Marica Branchesi