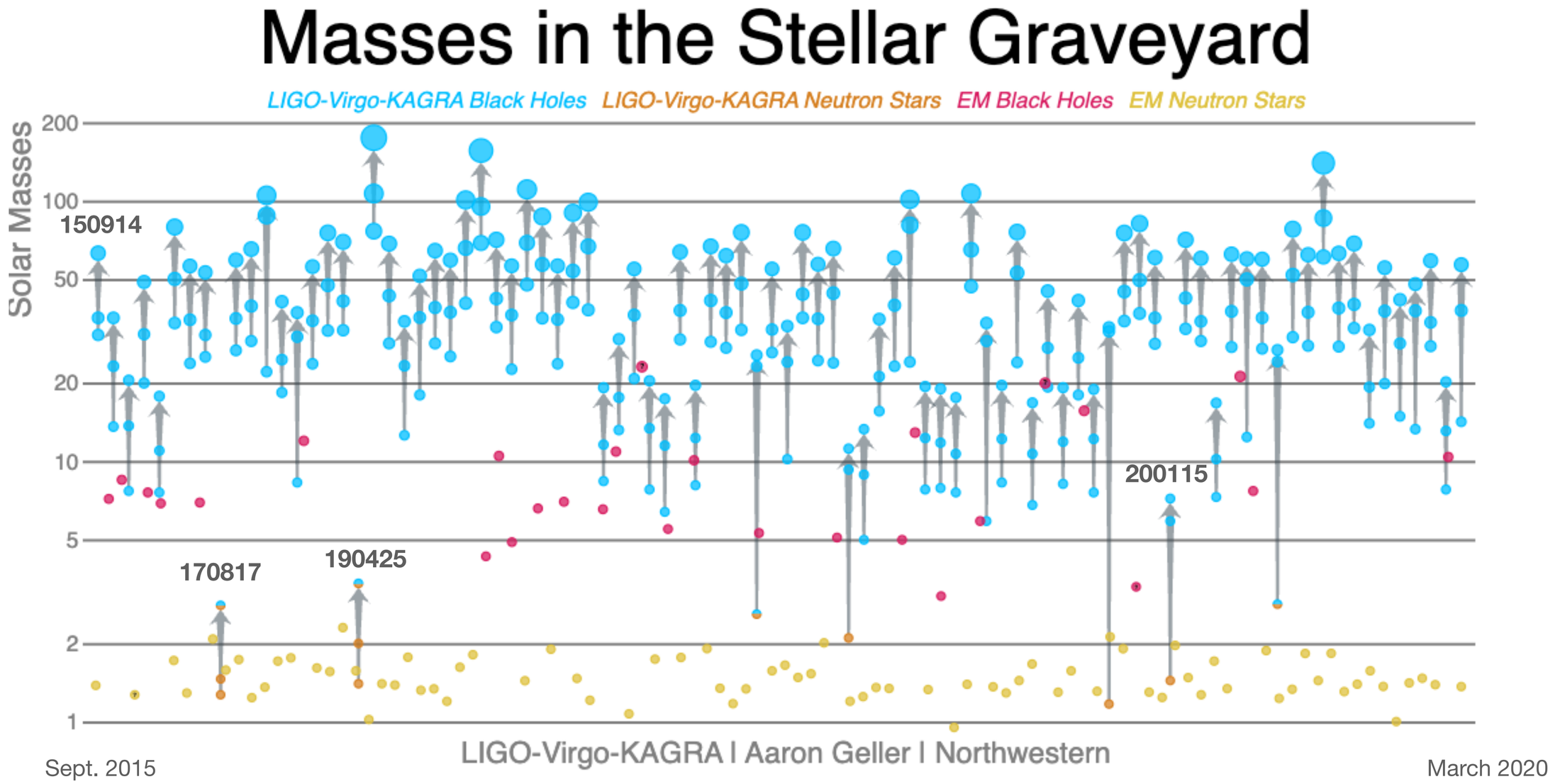
Compact Objects, GW and the ET opportunity

G. Ghirlanda - INAF, Osservatorio Astronomico di Brera

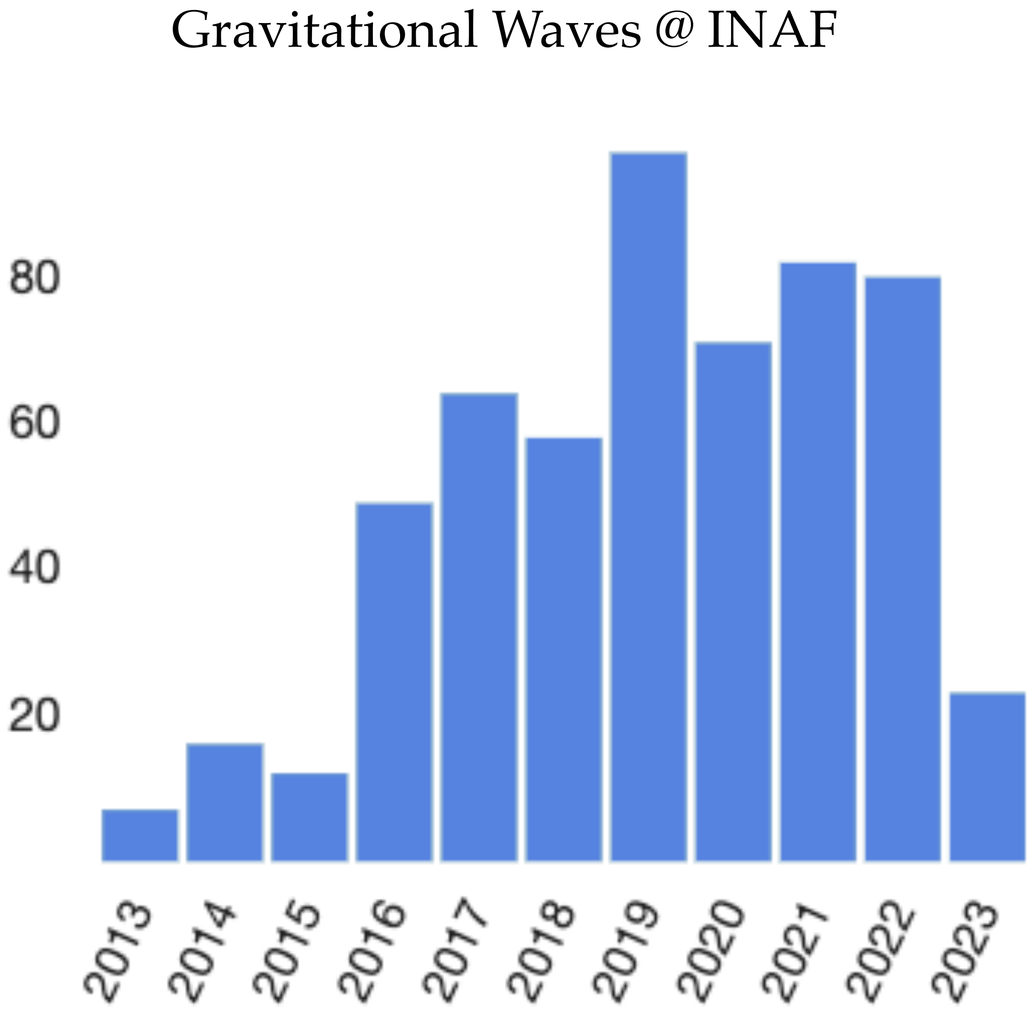
Giornate INAF @ Napoli, 2-5 Maggio, 2023

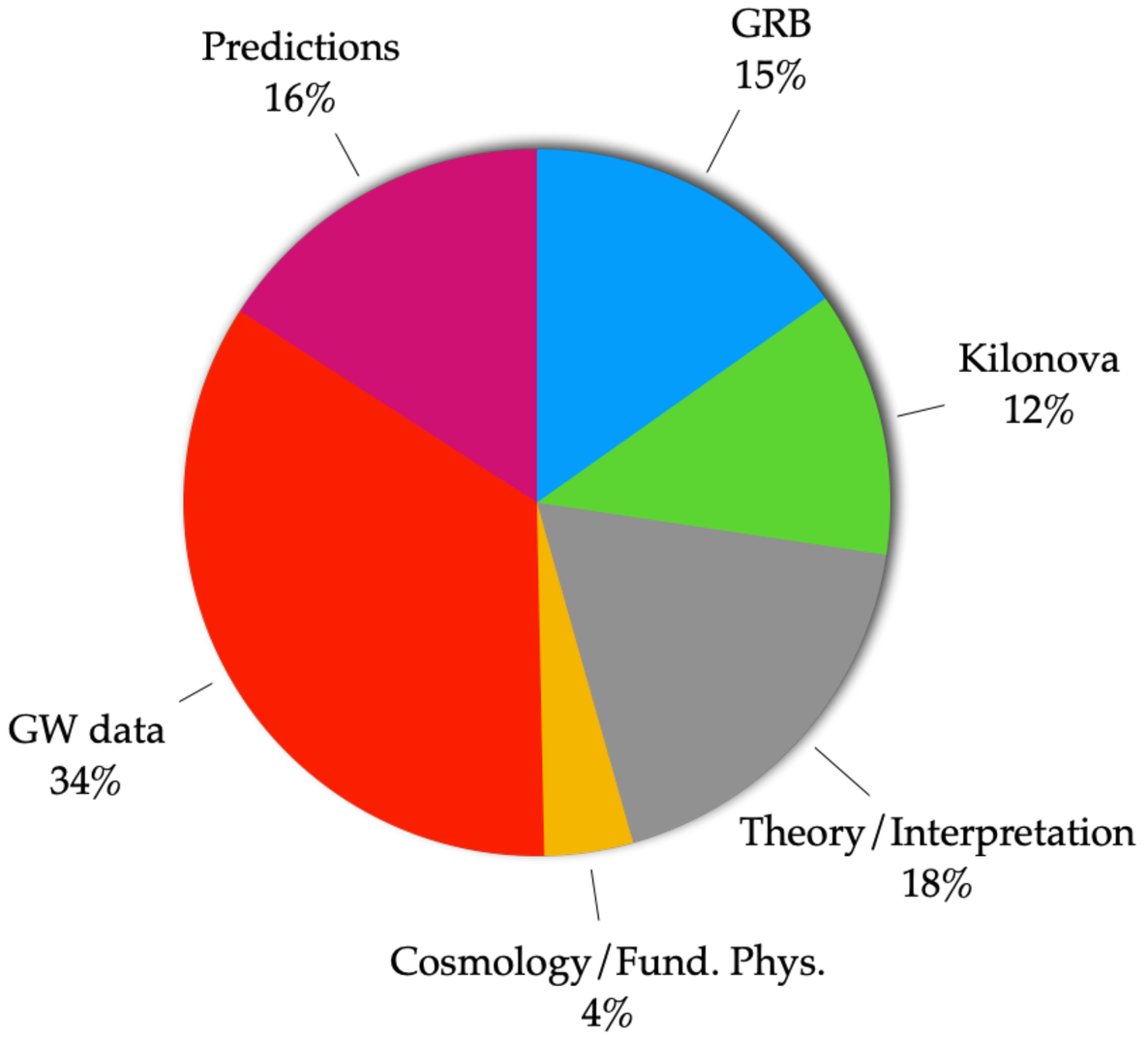
La rivoluzione GW



LIGO-Virgo-KAGRA / Aaron Geller / Northwestern

GW/MM @ INAF


Gravitational Waves @ INAF
80
60
40
20
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


Predictions
16%
GRB
15%
Kilonova
12%
GW data
34%
Theory / Interpretation
18%
Cosmology / Fund. Phys.
4%

GW @ INAF

- >15 Schede INAF
- 10-100 Participants
- All INAF Institutes

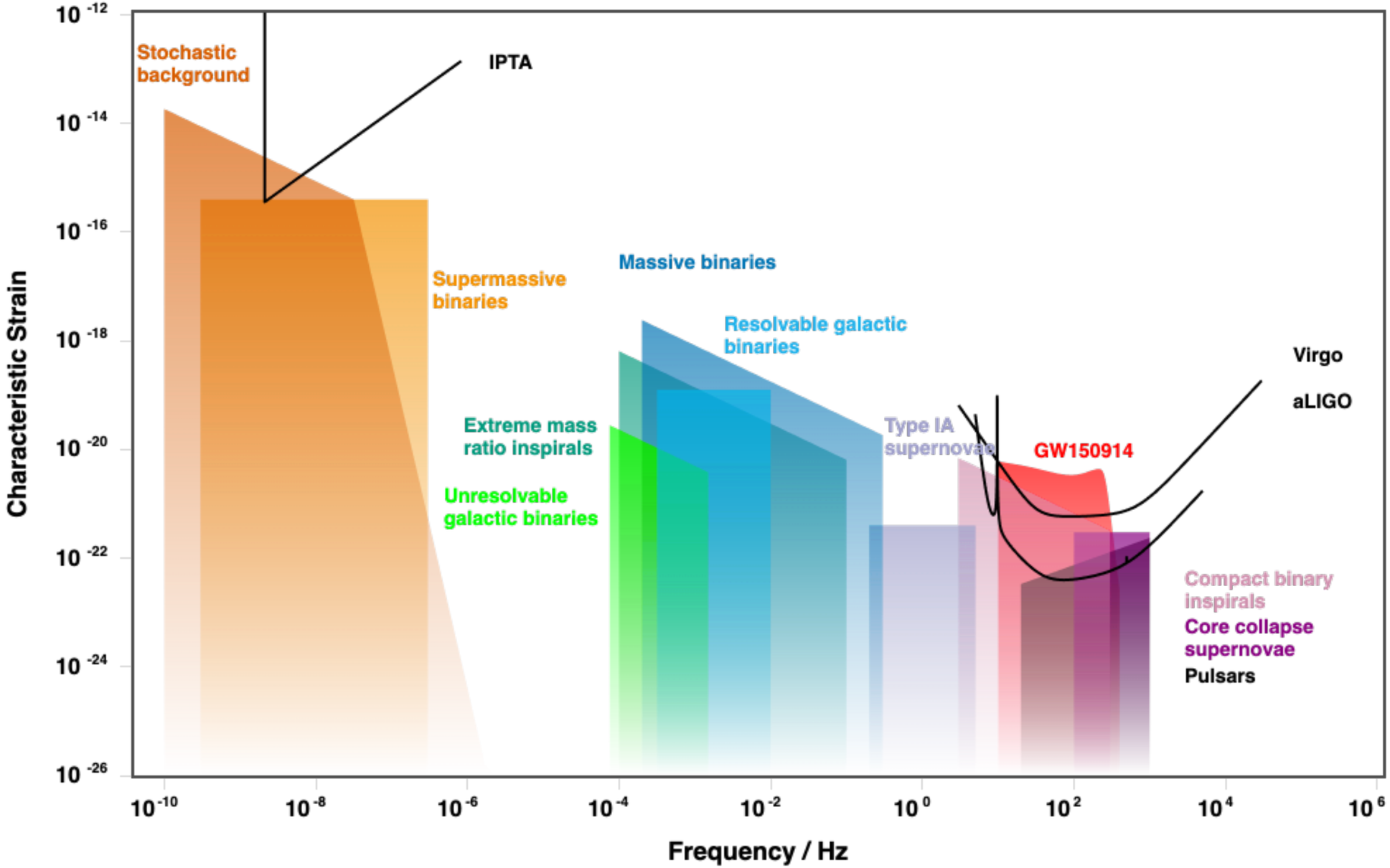
Observations (search/follow up)
Theory/Interpretation
Perspectives/next gen GW and MW detectors

~ 100 scientists (P.I. E. Brocato) from 21 Institutes (INAF+Uni), since O1

Coordinate with AGILE, Fermi, INTEGRAL, Swift teams, since O3

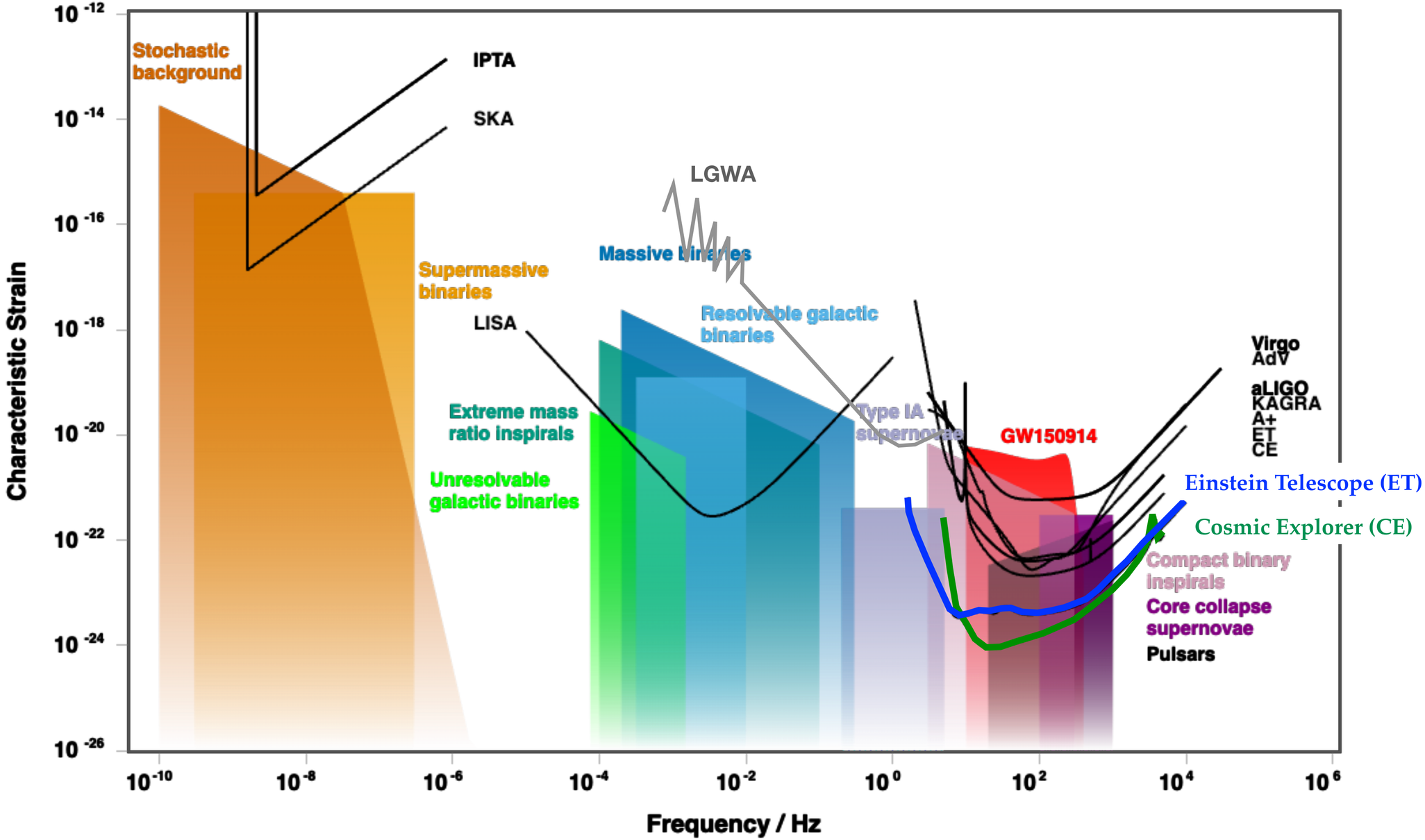
~ 250 scientists, since O3 (EM search and follow up | VLT+ALMA+HST+JWST)

Lo spettro GW: presente



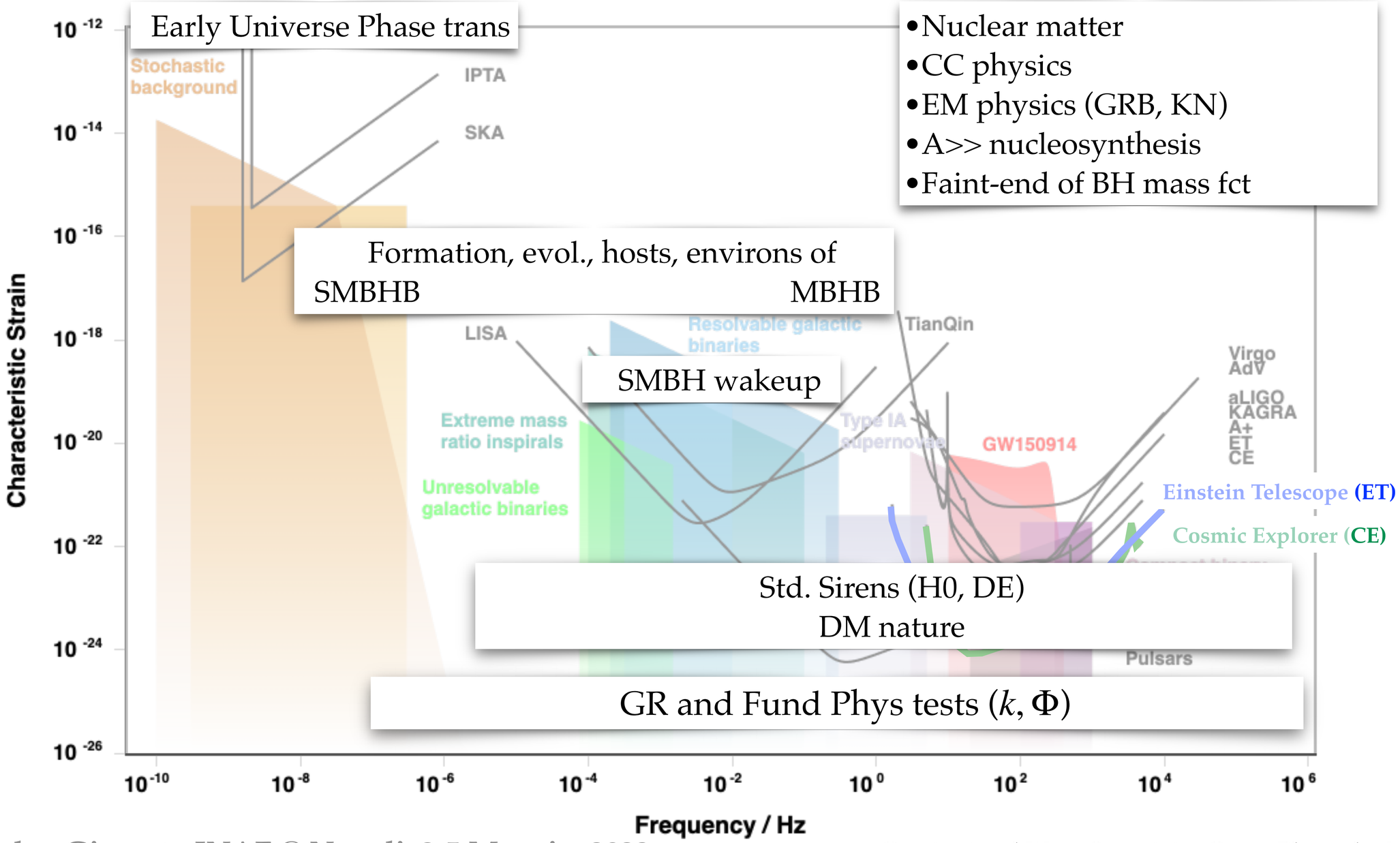
Gravitational Wave Sensitivity Curve Plotter by Moore,Cole,Berry

Lo spettro GW: presente e futuro



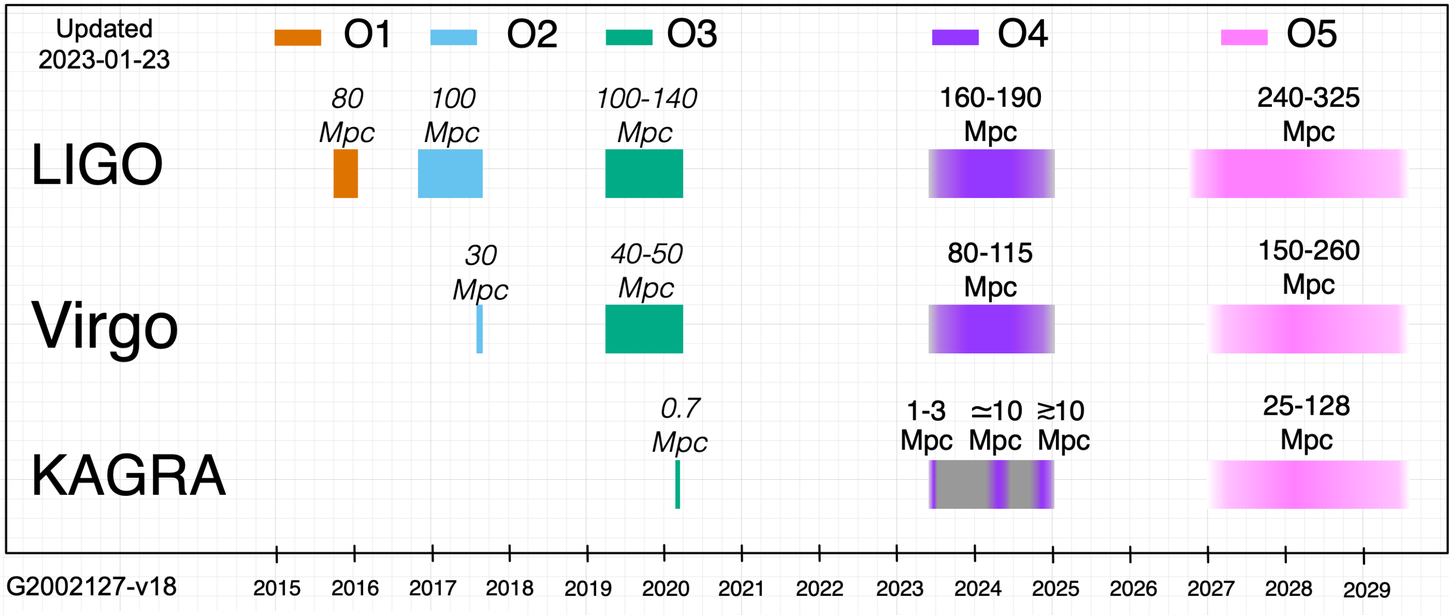
Gravitational Wave Sensitivity Curve Plotter by Moore,Cole,Berry

Big Questions



Gravitational Wave Sensitivity Curve Plotter by Moore,Cole,Berry

Prospettive a breve termine O4 e O5



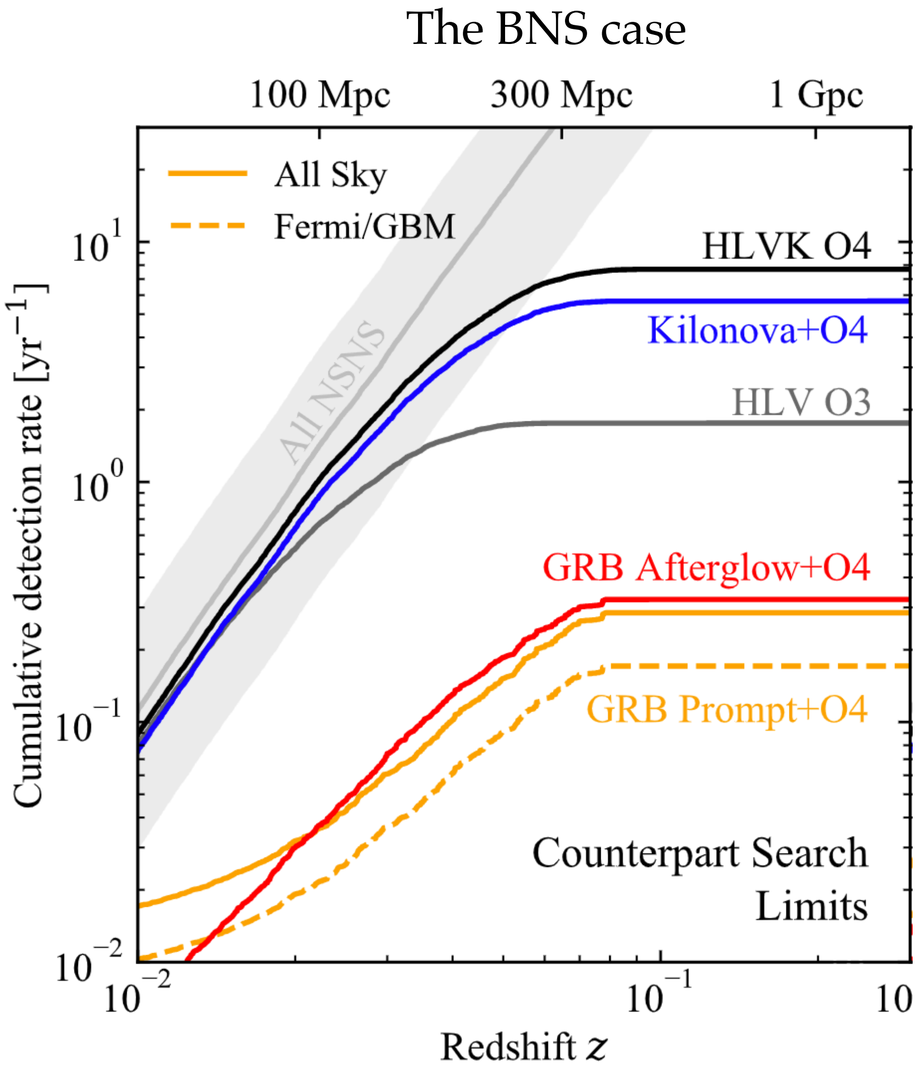
https://observing.docs.ligo.org/plan/

O(10) /yr GW [BNS, BHNS]

EM

O(100) /yr GW [BBH]

[IGWN, Public Alerts User Guide]



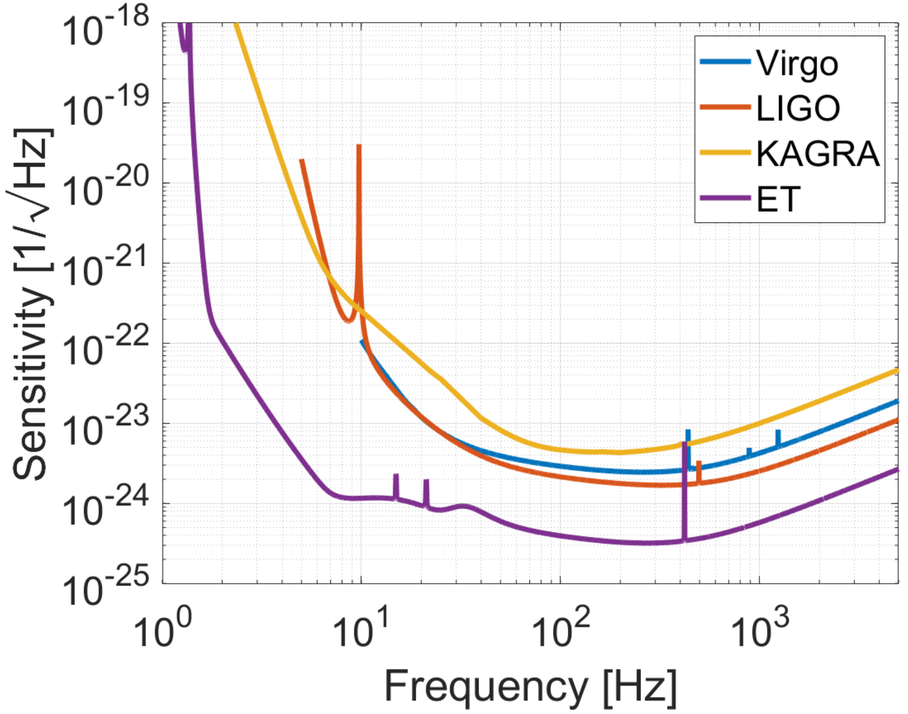
Colombo et al. 2022 (see also Patricelli et al. 2022)

Prospettive a lungo termine: 3G

Cosmic Explorer (CE): - US led

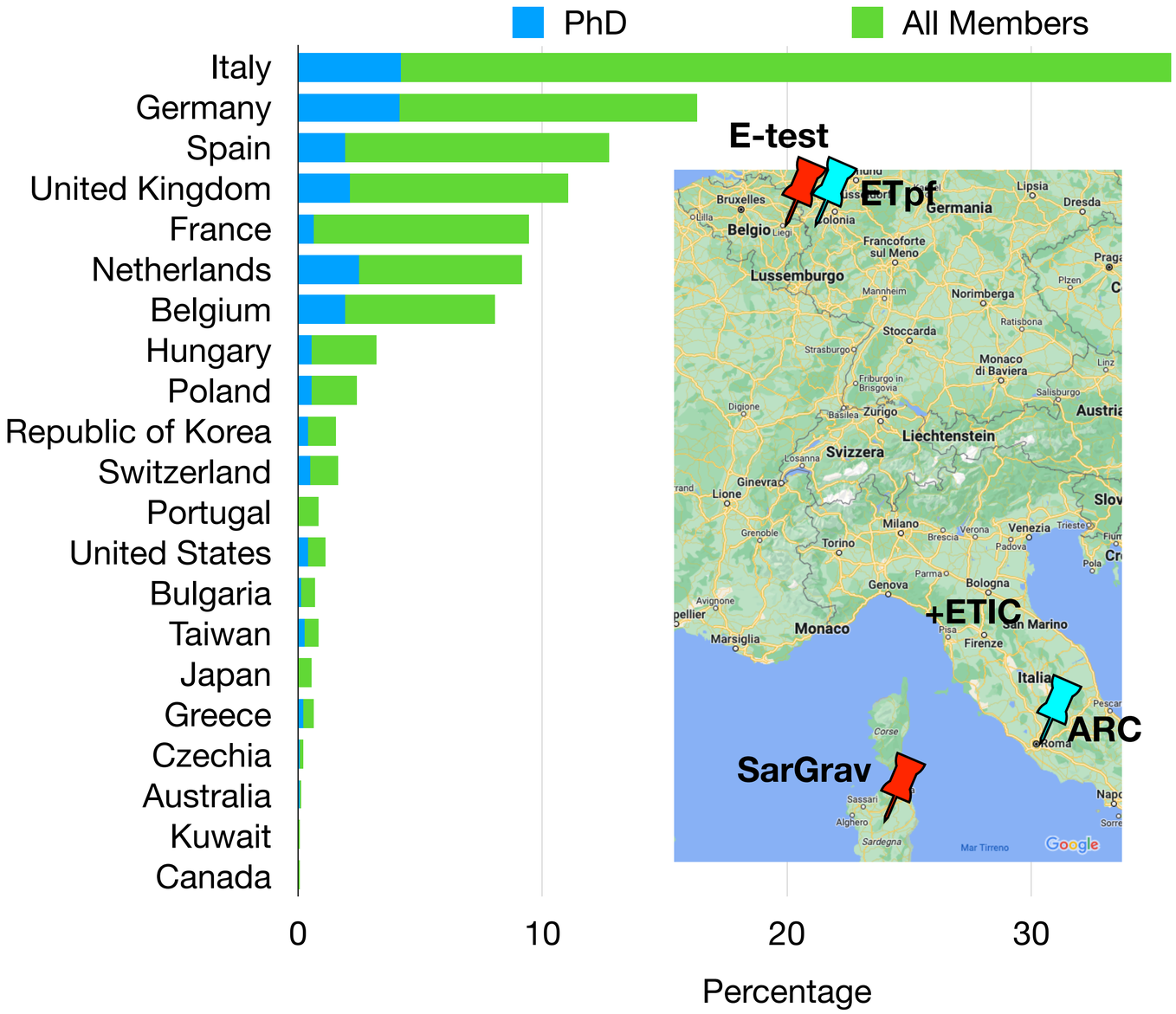
Einstein Telescope (ET) - EU led

Geometry: triangle vs 2L
Arm length: 10-15 km
Site characterisation



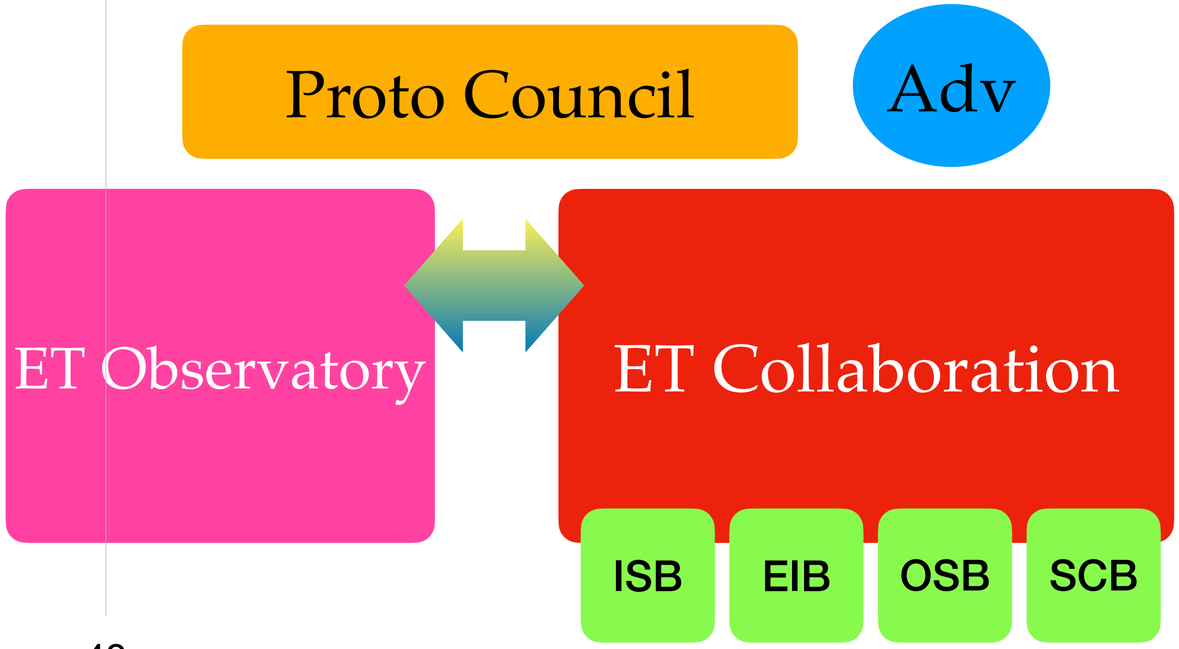
European Strategy Forum of Reaerch Insfrastructures (ESFRI) Roadmap 2021

Einstein Telescope



(April 2023) ETMD

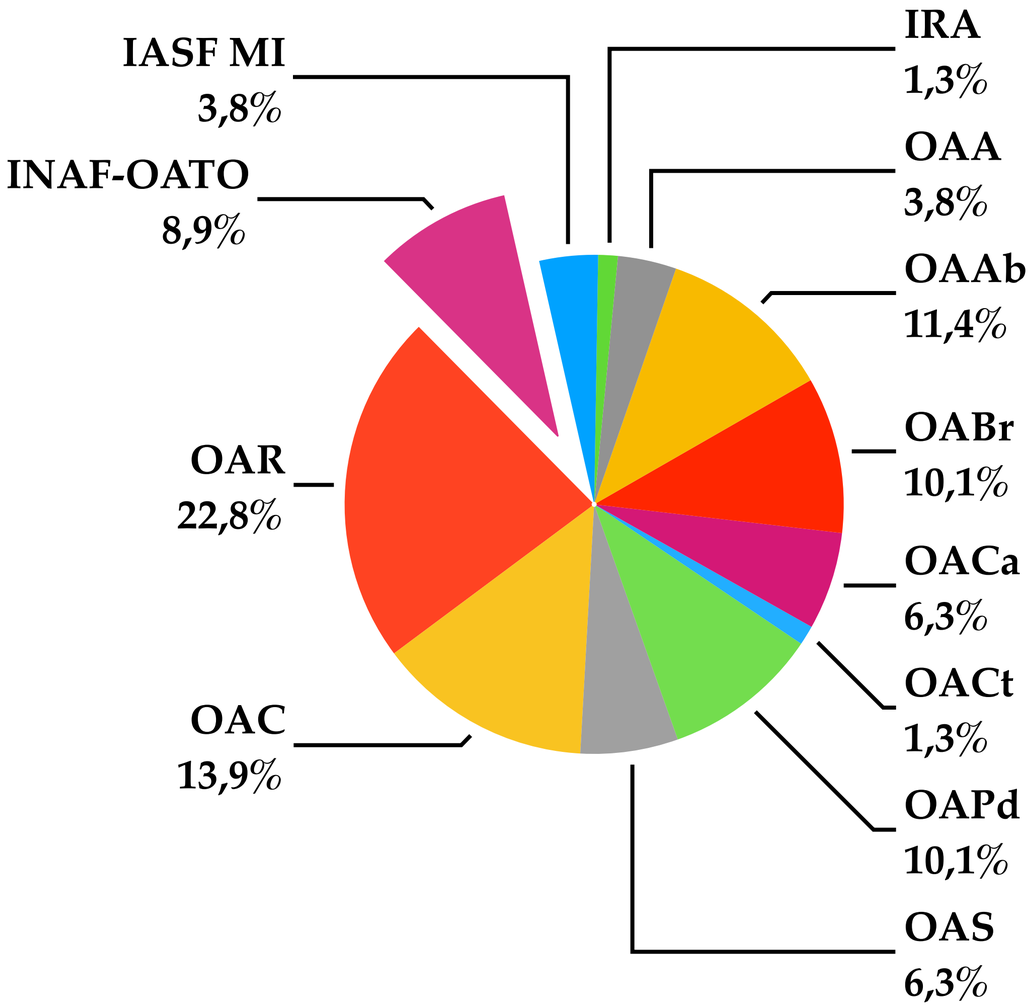
- **1402 members organised**
- **81 Research Units**
- **207 Institutions**



Einstein Telescope @ INAF

79 INAF members (6.5% of total 20% of Italian members)

INAF Research Units:
1.M. Crosta (INAF-OATO)
2.E. Brocato (INAF)



ET Collaboration

ISB EIB OSB SCB

ETIC (PNRR)
E. Cappellaro
A. Grado
ADONI (Esposito, Mennella)

1. **Fundamental Physics** : C. van den Broeck, P. Pani, R. Porto
2. **Cosmology** : A. Ghosh, A. Ricciardone, M. Sakellariadou
3. **Population Studies** : G. Cusin, M, Mapelli, A. Riotto
4. **Multimessenger observations** : G. Ghirlanda, S. Smartt, S. Vergani
5. **Synergies with other GW observatories** : M. Colpi, B. Sathyaprakash, N. Tamanini
6. **Nuclear Physics** : T. Dietrich, T. Hinderer, M. Oertel
7. **Stellar collapse and isolated neutron stars** : M.-A. Bizouard, E. Cappellaro, P. Cerda-Duran
8. **Waveforms** : L. Bernard, H. Pfeiffer, P. Schmidt
9. **Common Tools** : M. Bejger, Ik S. Heng, A. Maselli
10. **Data analysis platform** : C. van den Broeck, E. Cuoco, T. Regimbau, J. Veitch

Div S: future EM and neutrino experiments: M. Branchesi

Einstein Telescope

Ref: Branchesi et al., 2023. arXiv:2303.15923

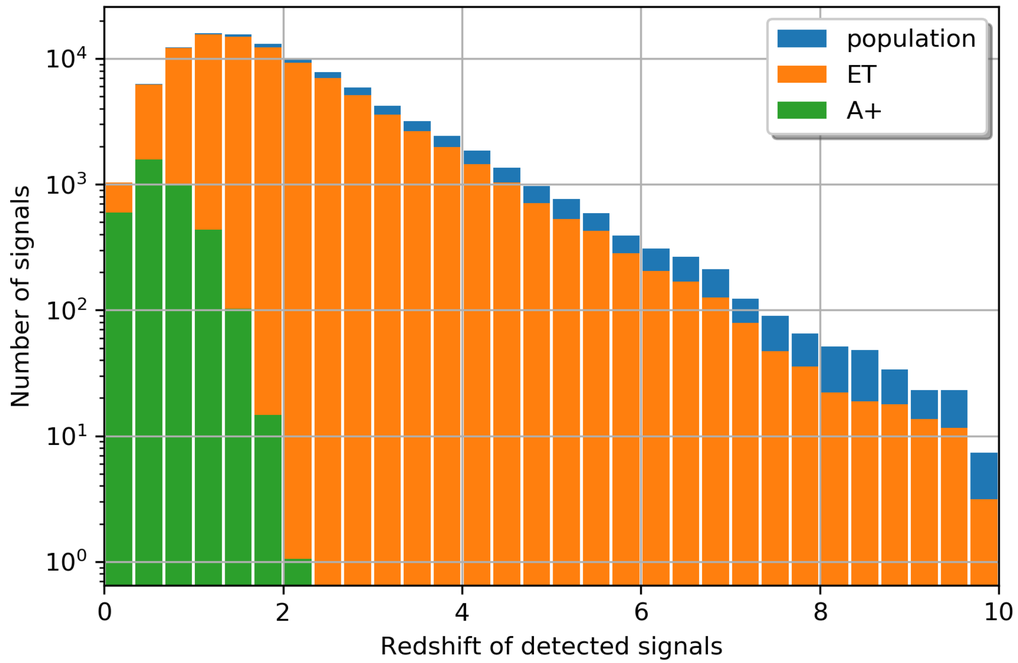
BBH ~ $\mathcal{O}(10^5\,\mathrm{yr}^{-1})$ [100 x LVKI O5] SNR>100 ~ $\mathcal{O}(10^3\,\mathrm{yr}^{-1})$

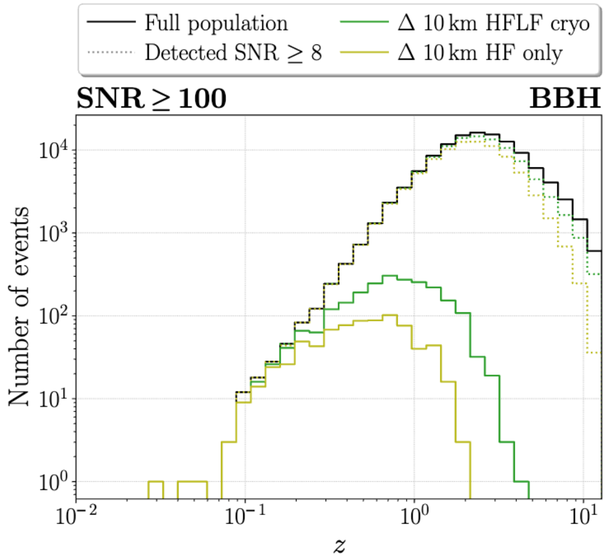
$\delta d_L < 5\,\%$

$\Omega < 100\,\mathrm{deg}^2$

$\delta \mathscr{M}_c < 0.1\,\%$

[ET minimal configuration. A factor 2-10 increase for different geometries]





- BBH formation channels
- PopIII BH
- Explore BH mass function
- Dark sirens Cosmology
- Stocastic (AGWB)
- EM counterparts

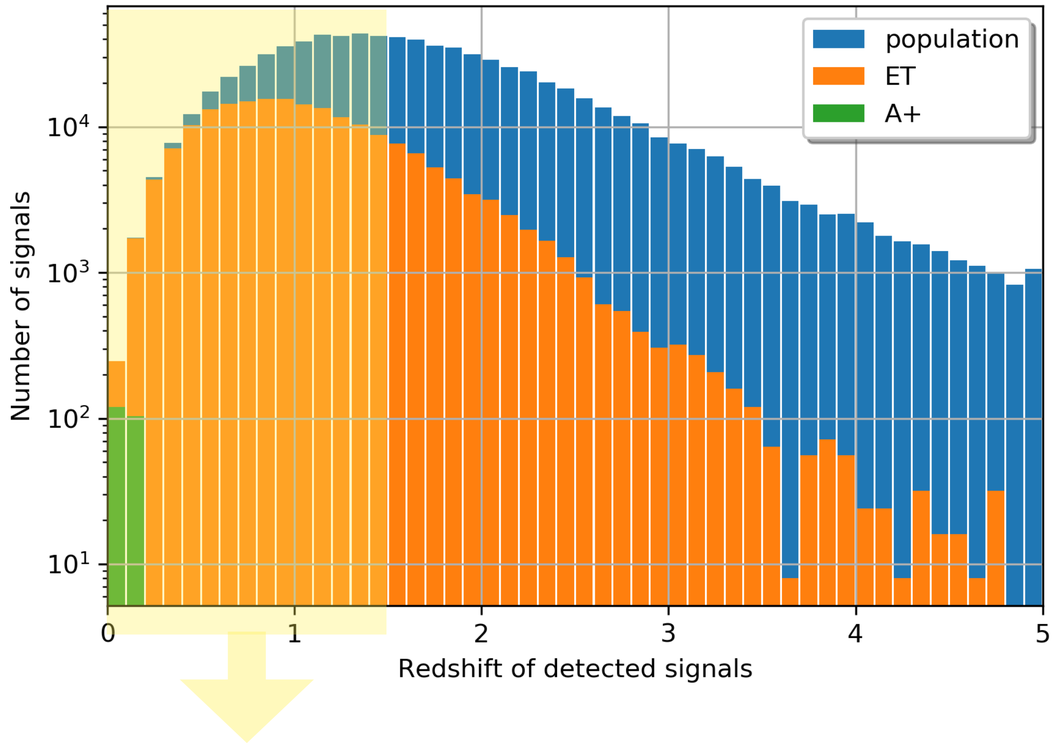
Einstein Telescope

Ref: Branchesi et al., 2023. arXiv:2303.15923

BNS ~ $\mathcal{O}(10^5\,\mathrm{yr}^{-1})$ → SNR>30 → $\mathcal{O}(10^3\,\mathrm{yr}^{-1})$ [~10% on axis]

~50% of short GRBs (next gen sat) + GW counterpart

[ET minimal configuration. A factor 2-10 increase for different geometries]

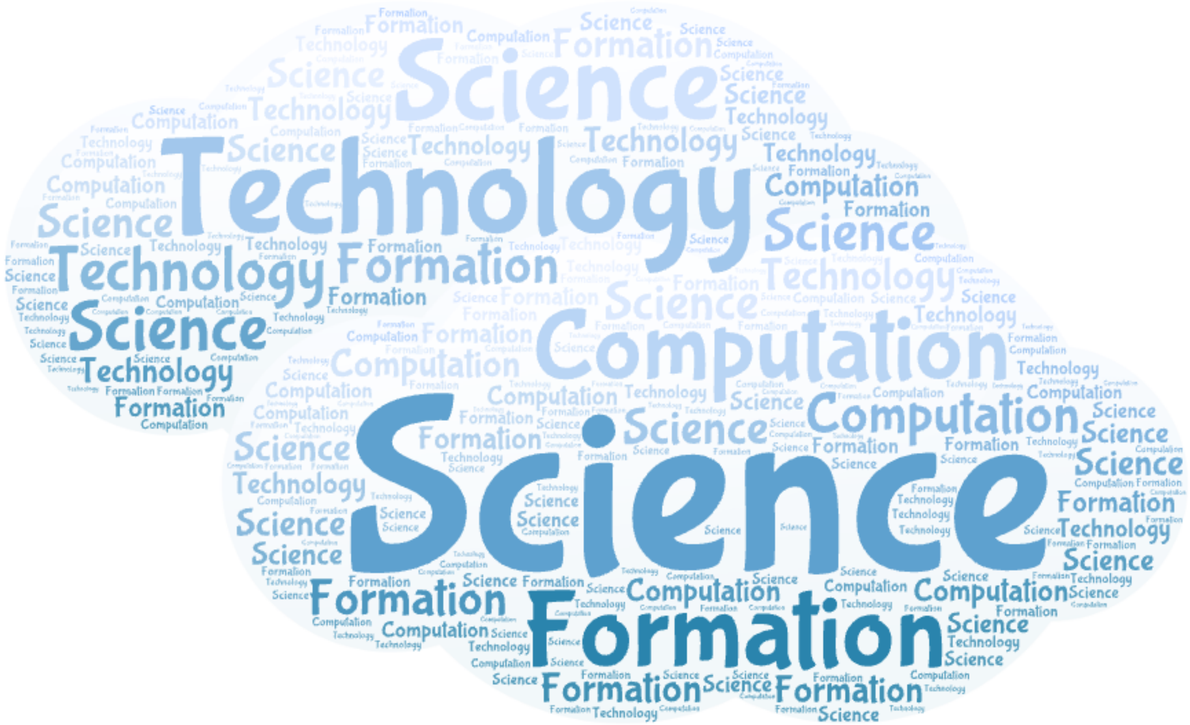


~ 40 KN yr^{-1} (VRO <10% time)

$\mathcal{O}(10^2\,\mathrm{yr}^{-1})$ >10 min pre-alert

- Nuclear matter physics
- Jet physics
- A>> nucleosynthesis
- Cosmology
- GR tests

Conclusioni



The future of GW astronomy, 3G detector Einstein Telescope, is LOUD.

@INAF: let's make it BRIGHT!