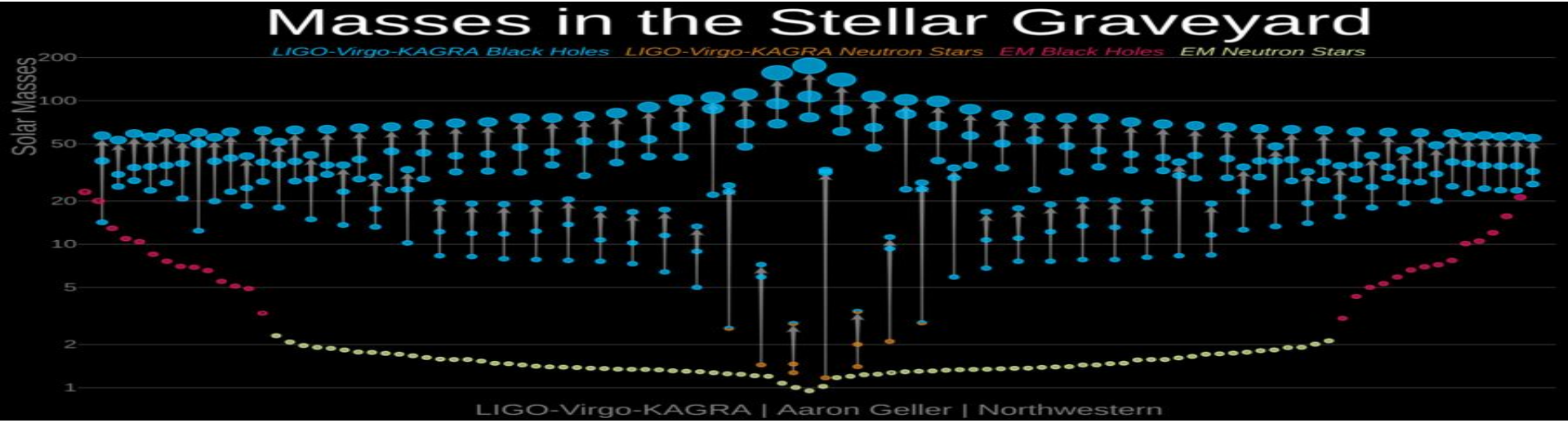
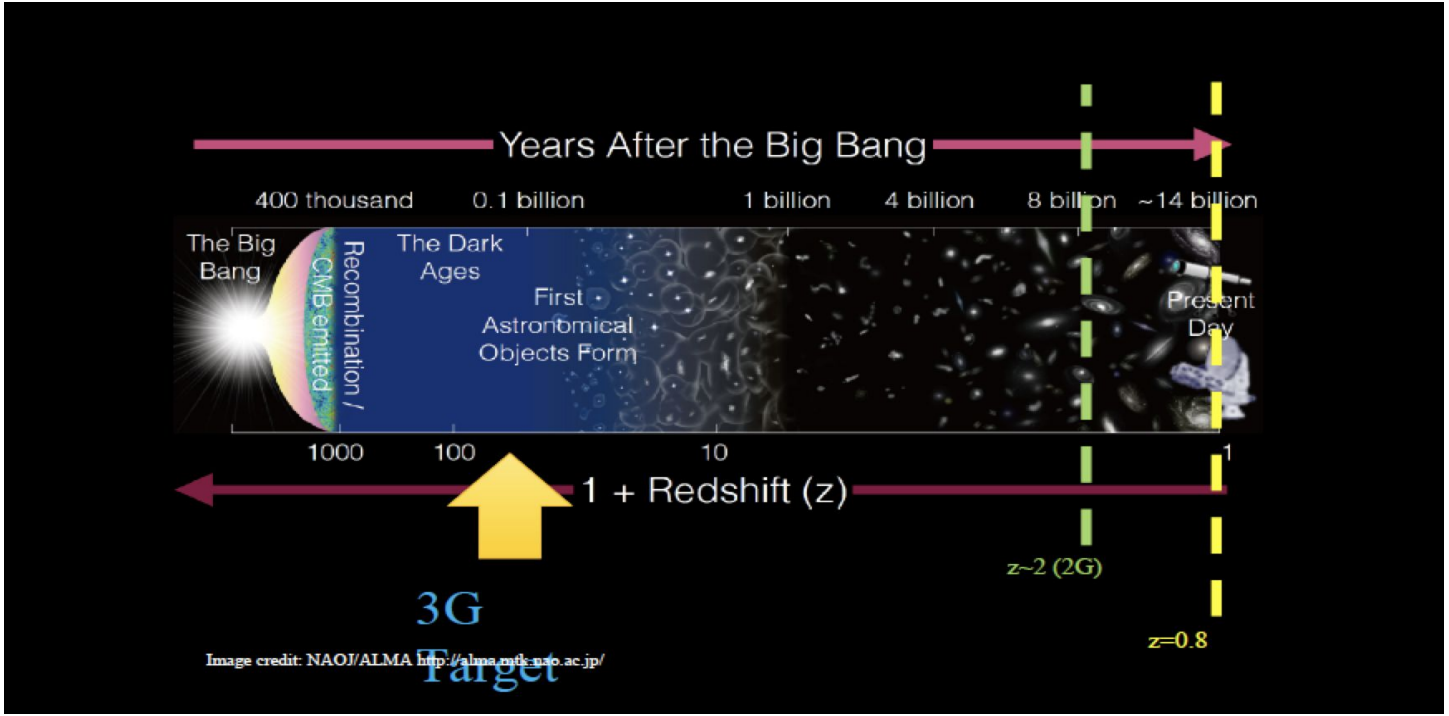
Observational Science Board

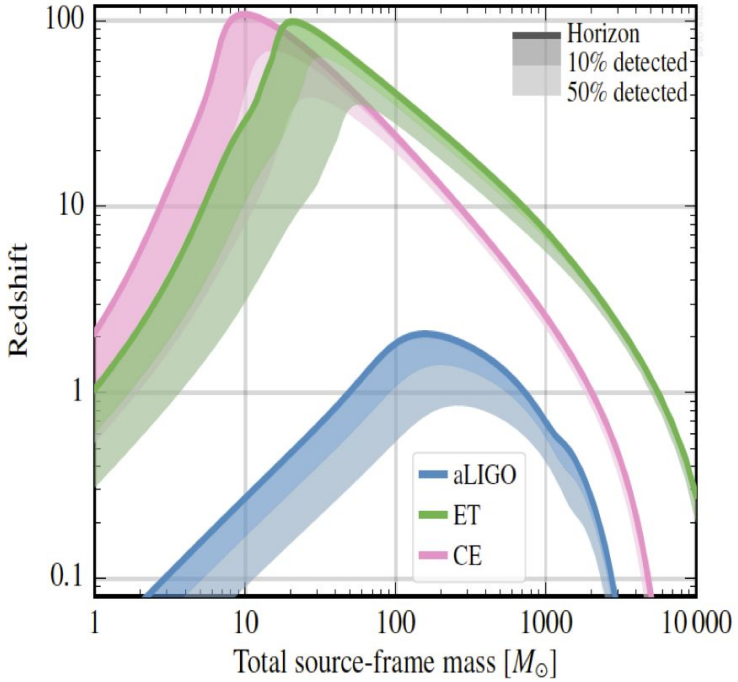


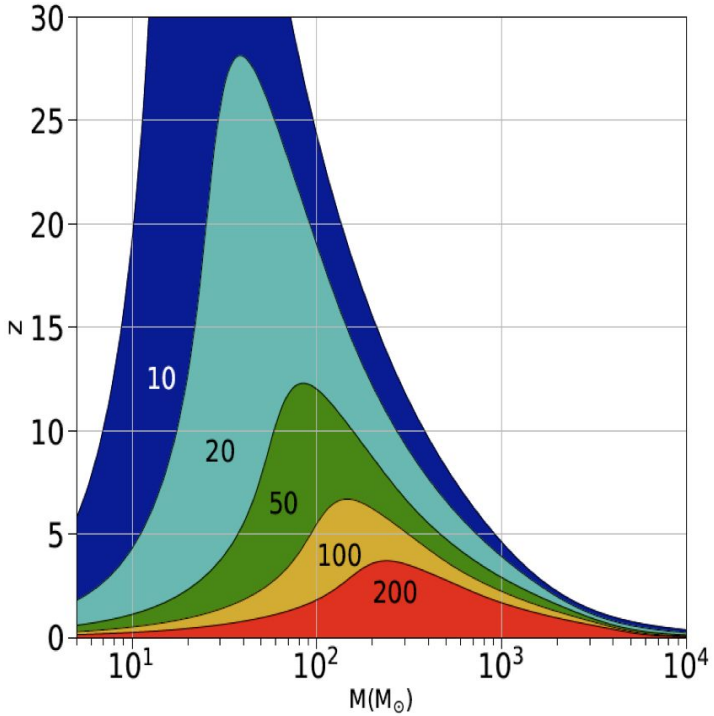
Marica Branchesi, Michele Maggiore, Ed Porter
ET Symposium, May 8-12, 2023

ET Science


Years After the Big Bang
400 thousand
0.1 billion
1 billion
4 billion
8 billion
~14 billion
The Big Bang
CMB emitted
Recombination /
The Dark Ages
First Astronomical Objects Form
Present Day
1000
100
10
1
1 + Redshift (z)
z~2 (2G)
3G
z=0.8
Image credit: NAOJ/ALMA http://alma.mtk.nao.ac.jp/
Target

ET Science

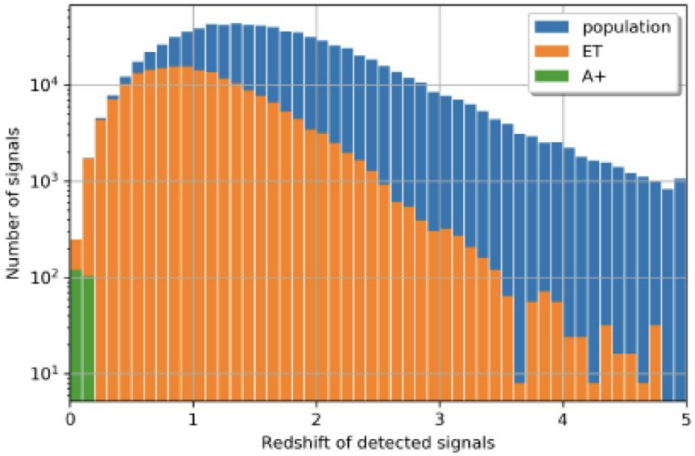




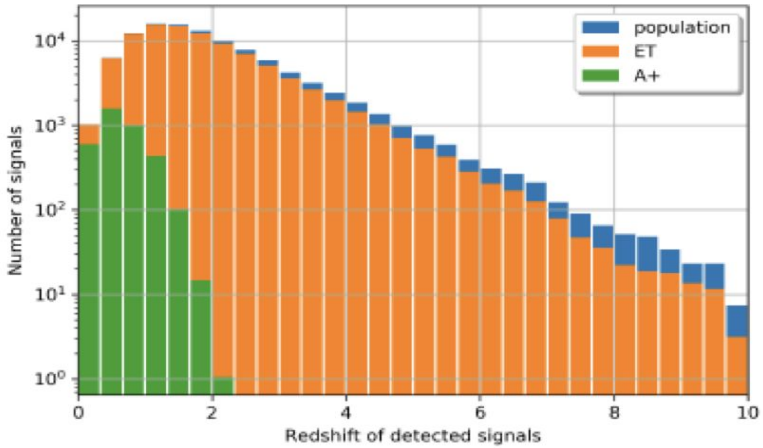
Michele Maggiore et al JCAP 03(2020) 050

ET Science

BINARY NEUTRON-STAR MERGERS



BINARY BLACK-HOLE MERGERS



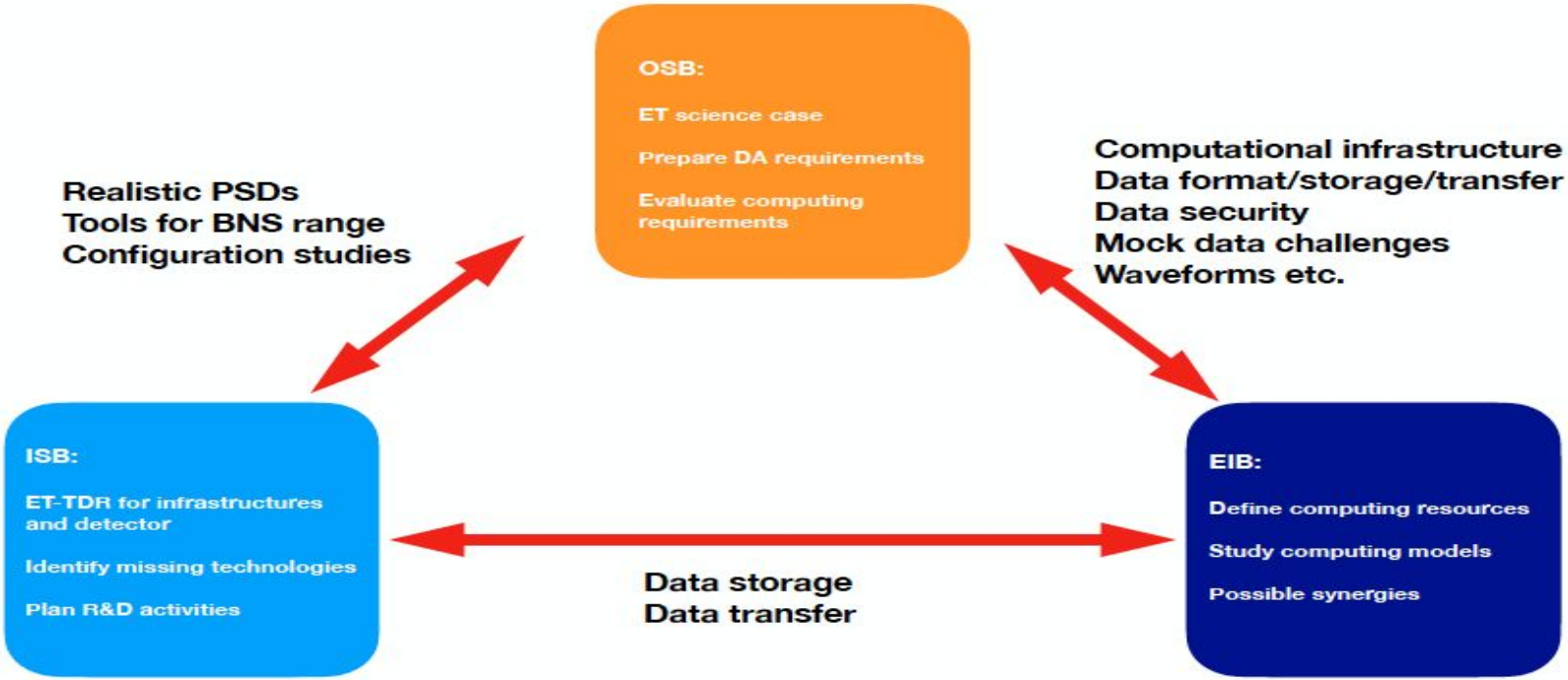
10^6 BBH mergers/yr up to z = 50
10^5 BNS mergers / yr up to z = 2
10-100 possible EM counterparts / year
High SNR events

M. Brachesi, M. Maggiore

Mandate of the OSB

- Investigate the science case for ET
- Produce the ET blue book
- Develop the analysis tools needed for science extraction
- Foster development with other GW experiments
- Foster relations with external EM and neutrino facilities
- Develop the data analysis platform

Synergies with the other boards



Current OSB Membership

Approximately 400 people subscribed to the OSB mailing list

10 divisions

Divisions hold monthly meetings

Development has begun on Blue Book

Covers the spectrum from pure theory to algorithmic development

OSB Divisions

- **Fundamental Physics** : Chris van den Broeck (vdbroeck@nikhef.nl), Paolo Pani (paolo.pani@uniroma1.it), Raphael Porto (rafael.porto@desy.de)
- **Cosmology** : Archisman Ghosh (Archisman.Ghosh@UGent.be), Angelo Ricciardone (angelo.ricciardone@pd.infn.it), Mairi Sakellariadou (mairi.sakellariadou@kcl.ac.uk)
- **Population Studies** : Giulia Cusin (giulia.cusin@unige.ch), Michela Mapelli (michela.mapelli@unipd.it), Antonio Riotto (Antonio.Riotto@unige.ch)
- **Multimessenger observations** : Giancarlo Ghirlanda (giancarlo.ghirlanda@inaf.it), Stephen Smartt (s.smartt@qub.ac.uk), Susanna Vergani (susanna.vergani@obspm.fr)
- **Synergies with other GW observatories** : Monica Colpi (monica.colpi@unimib.it), Bangalore Sathyaprakash (bss25@psu.edu), Nicola Tamanini (nicola.tamanini@l2it.in2p3.fr), Samaya Nissanke (s.m.nissanke@uva.nl)
- **Nuclear Physics** : Tim Dietrich (tim.dietrich@uni-potsdam.de), Tanja Hinderer (t.p.hinderer@uu.nl), Micaela Oertel (Micaela.Oertel@obspm.fr)
- **Stellar collapse and isolated neutron stars**: Marie-Anne Bizouard (marieanne.bizouard@oca.eu), Enrico Cappellaro (enrico.cappellaro@inaf.it), Pablo Cerda-Duran (pablo.cerda@uv.es)
- **Waveforms** : Laura Bernard (Laura.Bernard@obspm.fr), Harald Pfeiffer (harald.pfeiffer@aei.mpg.de), Patricia Schmidt (P.Schmidt@bham.ac.uk)
- **Common Tools** : Michal Bejger (bejger@camk.edu.pl), Ik Siong Heng (Ik.Heng@glasgow.ac.uk), Andrea Maselli (andrea.maselli@gssi.it)
- **Data analysis platform** : Chris van den Broeck (vdbroeck@nikhef.nl), Elena Cuoco (elena.cuoco@sns.it), Tania Regimbau (tania.regimbau@lapp.in2p3.fr), John Veitch (John.Veitch@glasgow.ac.uk)

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Scientific landscape in 2035+

M. Branchesi

Public OSB wiki

https://www.et-gw.eu/index.php/observational-science-board

Information on : who we are, what we do, most recent publications, full OSB publication history.

Approximately 40 OSB papers since the ET Collaboration was formed in 2022

Publications will be updated on a monthly basis

Recent scientific work: CoBA study

https://arxiv.org/abs/2303.15923

- Study of L and triangular configurations of different lengths
- Investigated CBC, stochastic background and MMA
- 197 pages
- 75 authors

Science with the Einstein Telescope: a comparison of different designs

Marica Branchesi,[1,2] Michele Maggiore,[3,4] David Alonso,[5] Charles Badger,[6] Biswajit Banerjee,[1,2] Freija Beirnaert,[7] Swetha Bhagwat,[8,9] Guillaume Boileau,[10,11] Ssohrab Borhanian,[12] Daniel David Brown,[13] Man Leong Chan,[14] Giulia Cusin,[15,3,4] Stefan L. Danilishin,[16,17] Jerome Degallaix,[18] Valerio De Luca,[19] Arnab Dhani,[20] Tim Dietrich,[21,22] Ulyana Dupletsa,[1,2] Stefano Foffa,[3,4] Gabriele Franciolini,[8] Andreas Freise,[23,16] Gianluca Gemme,[24] Boris Goncharov,[1,2] Archisman Ghosh,[7] Francesca Gulminelli,[25] Ish Gupta,[20] Pawan Kumar Gupta,[16,26] Jan Harms,[1,2] Nandini Hazra,[1,2,27] Stefan Hild,[16,17] Tanja Hinderer,[28] Ik Siong Heng,[29] Francesco Iacovelli,[3,4] Justin Janquart,[16,26] Kamiel Janssens,[10,11] Alexander C. Jenkins,[30] Chinmay Kalaghatgi,[16,26,31] Xhesika Koroveshi,[32,33] Tjonnie G. F. Li,[34,35] Yufeng Li,[36] Eleonora Loffredo,[1,2] Elisa Maggio,[22] Michele Mancarella,[3,4,37,38] Michela Mapelli,[39,40,41] Katarina Martinovic,[6] Andrea Maselli,[1,2] Patrick Meyers,[42] Andrew L. Miller,[43,16,26] Chiranjib Mondal,[25] Niccolò Muttoni,[3,4] Harsh Narola,[16,26] Micaela Oertel,[44] Gor Oganesyan,[1,2] Costantino Pacilio,[8,37,38] Cristiano Palomba,[45] Paolo Pani,[8] Antonio Pasqualetti,[46] Albino Perego,[47,48] Carole Périgois,[39,40,41] Mauro Pieroni,[49,50] Ornella Juliana Piccinni,[51] Anna Puecher,[16,26] Paola Puppo,[45] Angelo Ricciardone,[52,39,40] Antonio Riotto,[3,4] Samuele Ronchini,[1,2] Mairi Sakellariadou,[6] Anuradha Samajdar,[21] Filippo Santoliquido,[39,40,41] B.S. Sathyaprakash,[20,53,54] Jessica Steinlechner,[16,17] Sebastian Steinlechner,[16,17] Andrei Utina,[16,17] Chris Van Den Broeck,[16,26] and Teng Zhang[9,17]

Upcoming science: ET Mock Data Challenges

Produce realistic simulated data at the output of ET (and CE), in order to:

- Train newbies in data analysis (tutorials/simple data sets)
- Stress-test the current computational infrastructure
- Develop/test adapted data analysis and parameter estimation methods
- Prepare the interpretation of the results in term of astrophysics, cosmology and fundamental physics

Upcoming science: ET Mock Data Challenges

Important starting point for both the OSB and EIB

Computing

- Stress-testing the current computational infrastructure
- CVMFS, Open Science Grid
- Computational cost of the current pipelines for high rate/large template bank

Data Analysis and Science

- Compute the detection efficiency
- Obtain the mass/spin distributions
- Determine the rate of each population
- Measure the neutron star equation of state
- Measure H0
- Measure energy density of the background

OSB F2F

- OSB science requires contributions and interactions from many domains
- OSB provides a wide community for people to interact
- Lots of interesting talks, especially by young researchers on theory, multi-messenger astronomy and data analysis
- We are also beginning to see a lot of cross-domain talks as people are able to take advantage of a wide range of expertise
- People are excited about doing ET science

Synergy with the LVK / EM / neutrino communities

A lot of OSB science will be informed from O4/O5/O5+:

- Constraints on populations, nuclear EOS, cosmology, tests of GR
- EM follow-ups? More GW170817s?
- Better understanding of waveform and analysis systematics
- Algorithmic development
- New methods (algorithms) and technologies (computing infrastructure)
- 1st supernova observation?

Conclusion

- ➔ The OSB is a very active environment and is growing
- ➔ We have strong links with the ISB and EIB
- ➔ Our first large target is production of the Blue Book
- ➔ Lots of ongoing work on theoretical and astrophysical aspects
- ➔ We are beginning our first MDC soon
- ➔ Feel free to join us…