



# Einstein Telescope: il ruolo INAF

**Giancarlo Ghirlanda**

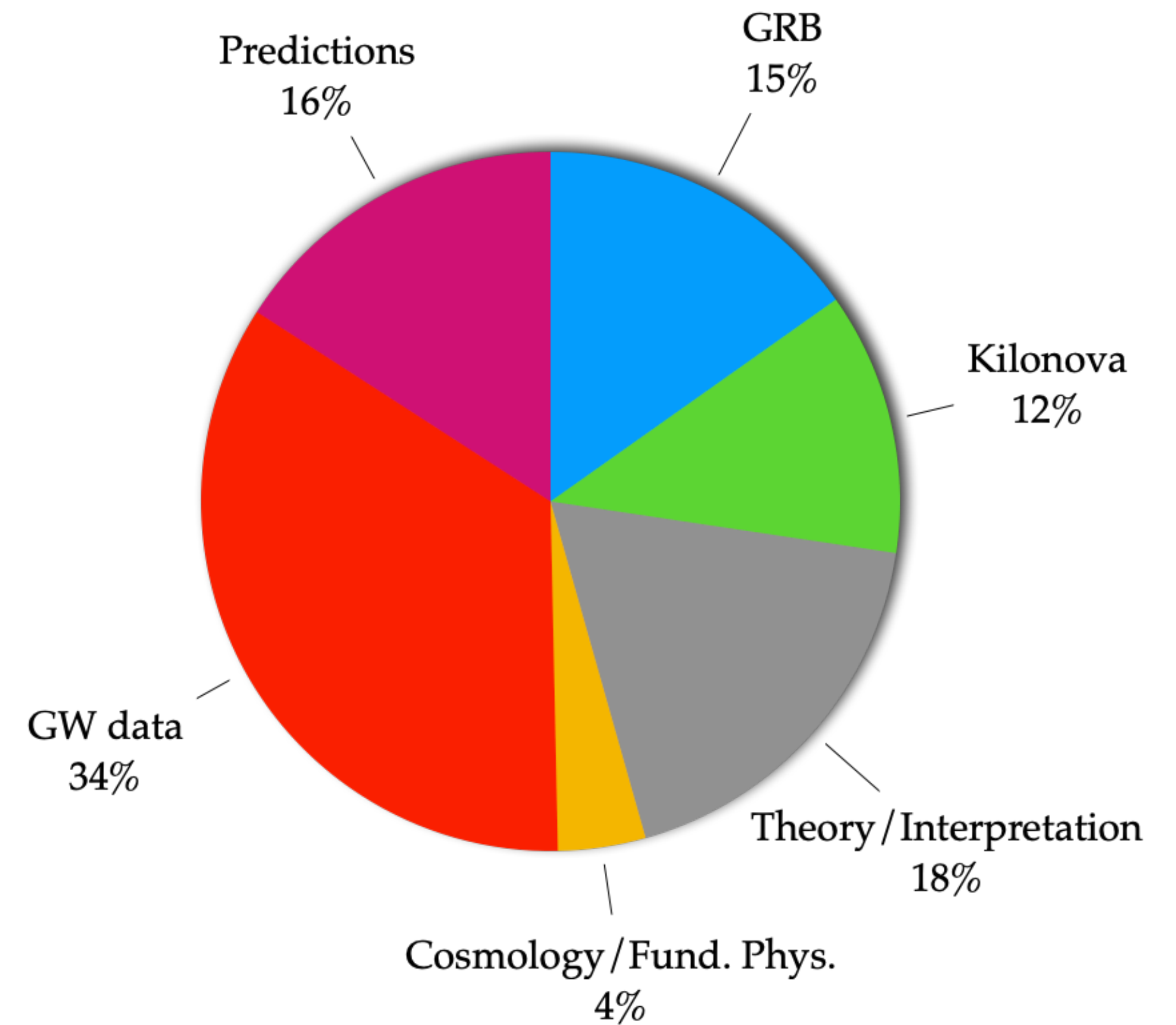
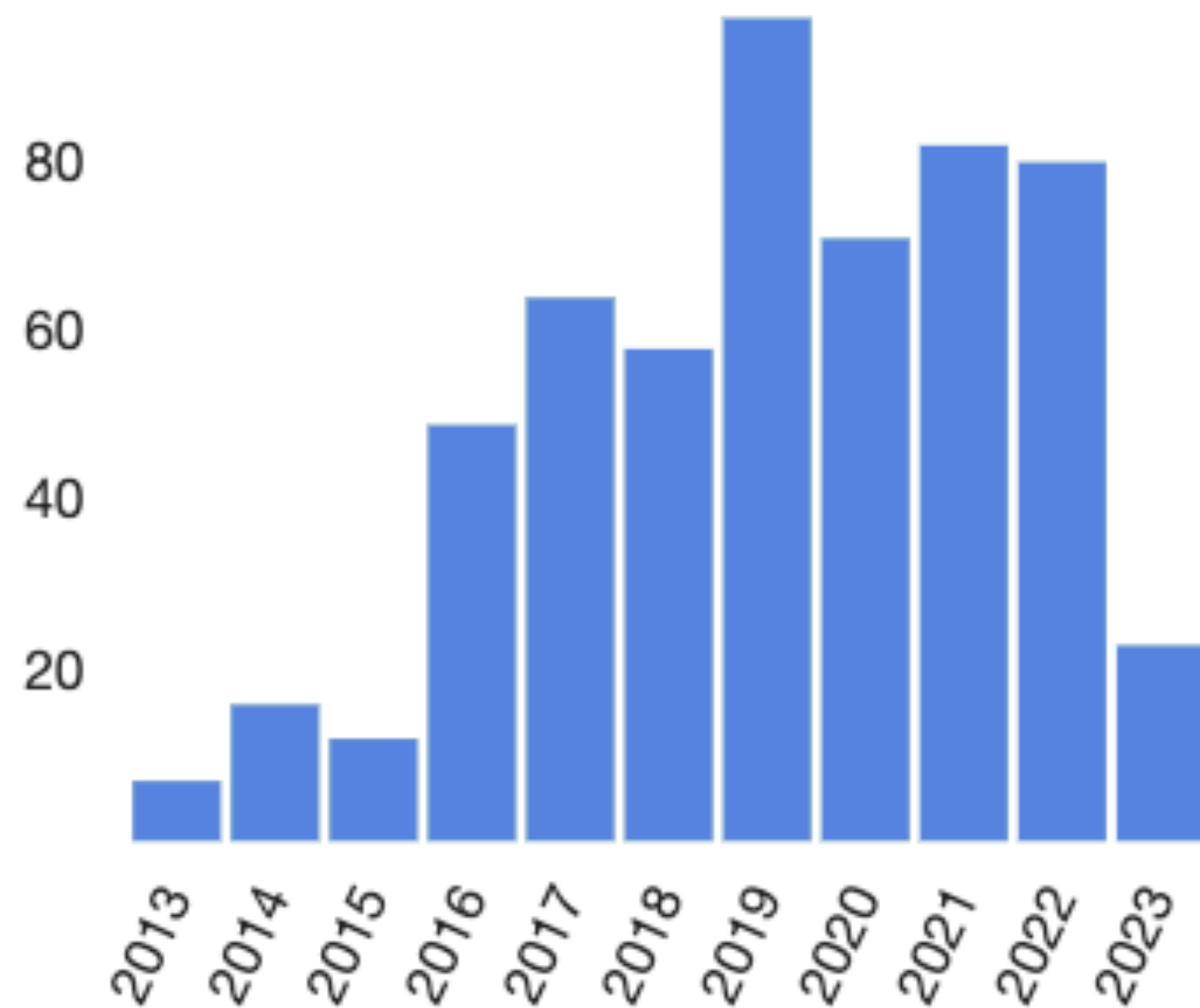
**Istituto Nazionale di Astrofisica (INAF)**

**Osservatorio Astronomico di Brera**



# Gravitational waves and MM astronomy @ INAF

## Gravitational Waves @ INAF



# INAF excellence in MMastro



~ 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)

Radio

MicroW

Infrared

Visible

Ultraviolet

X-rays

Gamma-rays



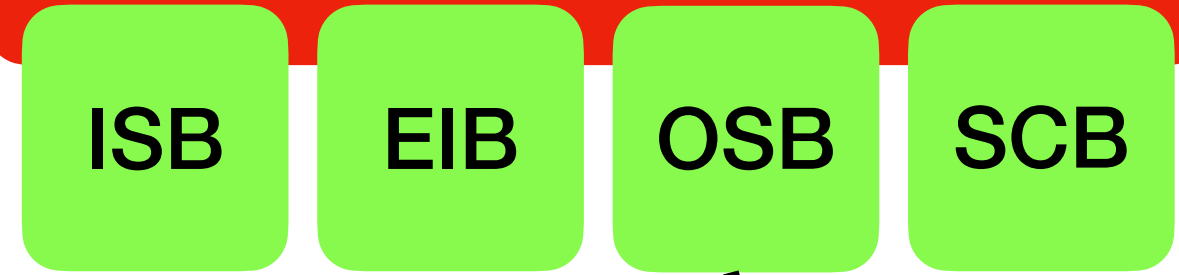
# INAF in Einstein Telescope

## INAF Research Units:

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

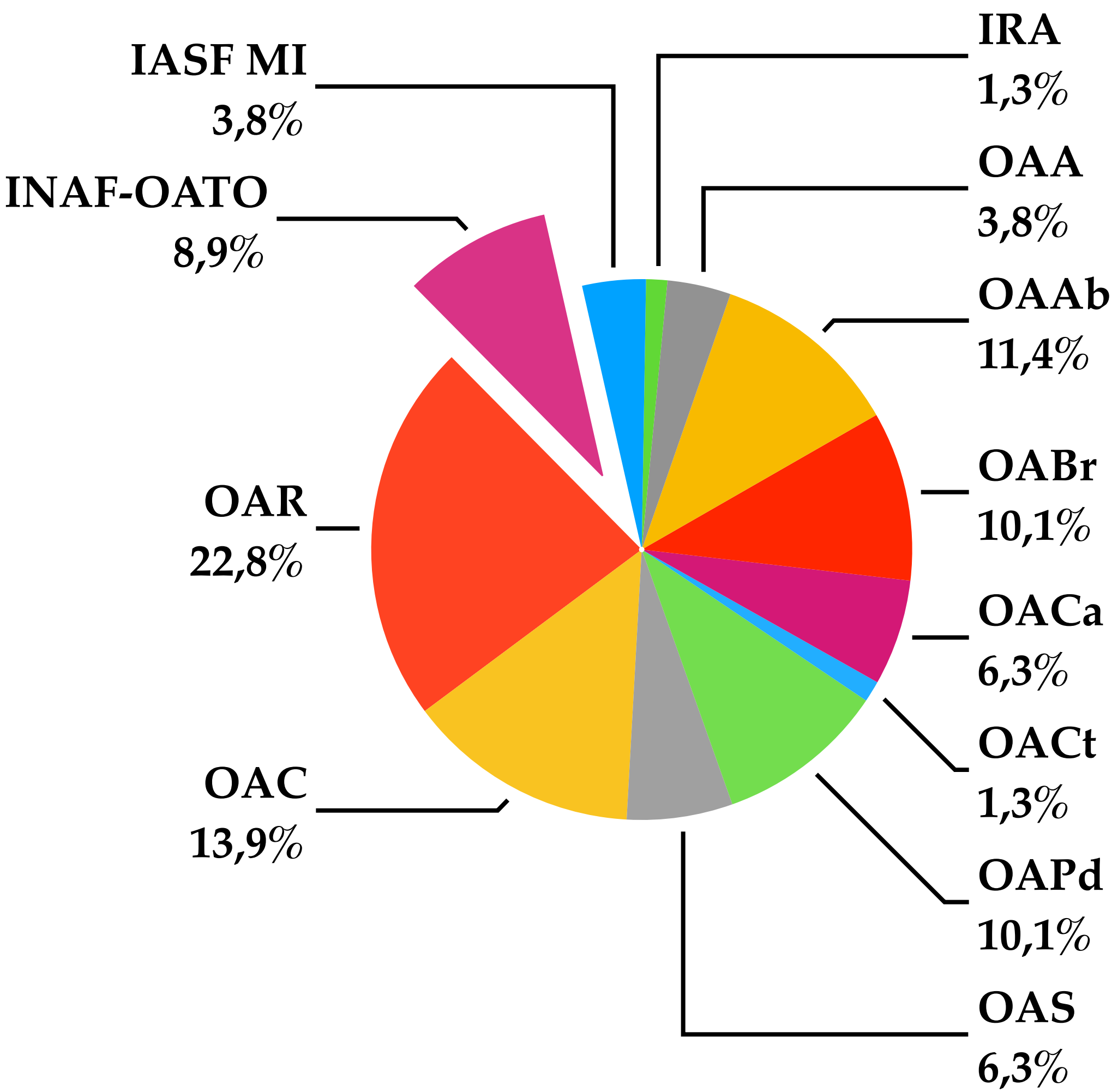
~80 INAF members (6.5% of total 20% of Italian members)

## ET Collaboration



- 1.... ..
- 2. Pipe Arm Vacuum: P. Chiggiato, **A. Grado**, N. van Remortel
- 3....
- 4....

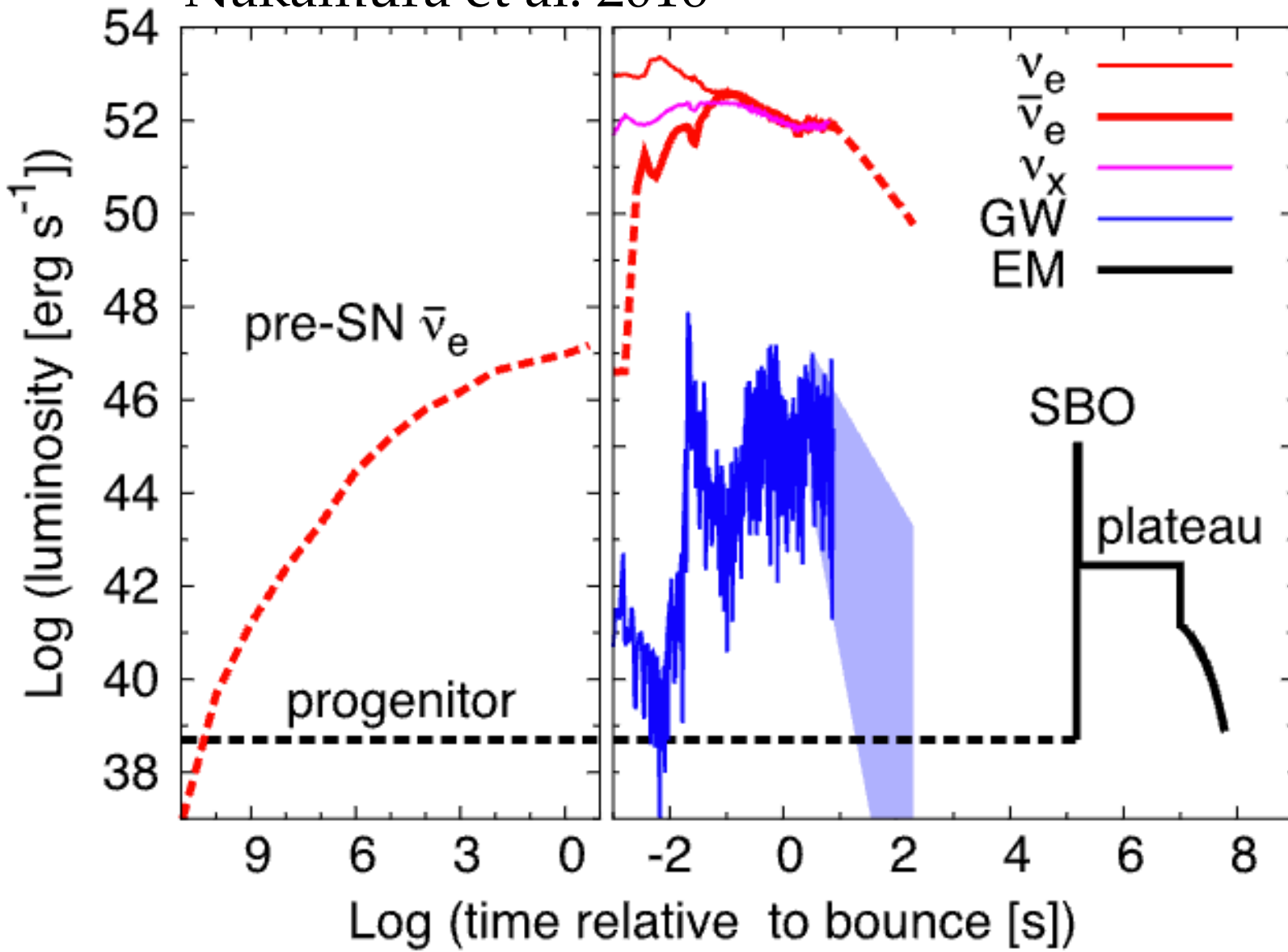
- 1. **Fundamental Physics** : C. van den Broeck, P. Pani, R. Porto
- 2. **Cosmology** : A. Ghosh, A. Ricciardone, M. Sakellariadou
- 3. **Population Studies** : G. Cusin, M, Mapelli, A. Riotto
- 4. **Multimessenger observations** : **G. Ghirlanda**, (S. Smartt) A. Levan, S. Vergani
- 5. **Synergies 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**) **M. Limongi**, 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



Red names = INAF

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

Nakamura et al. 2016

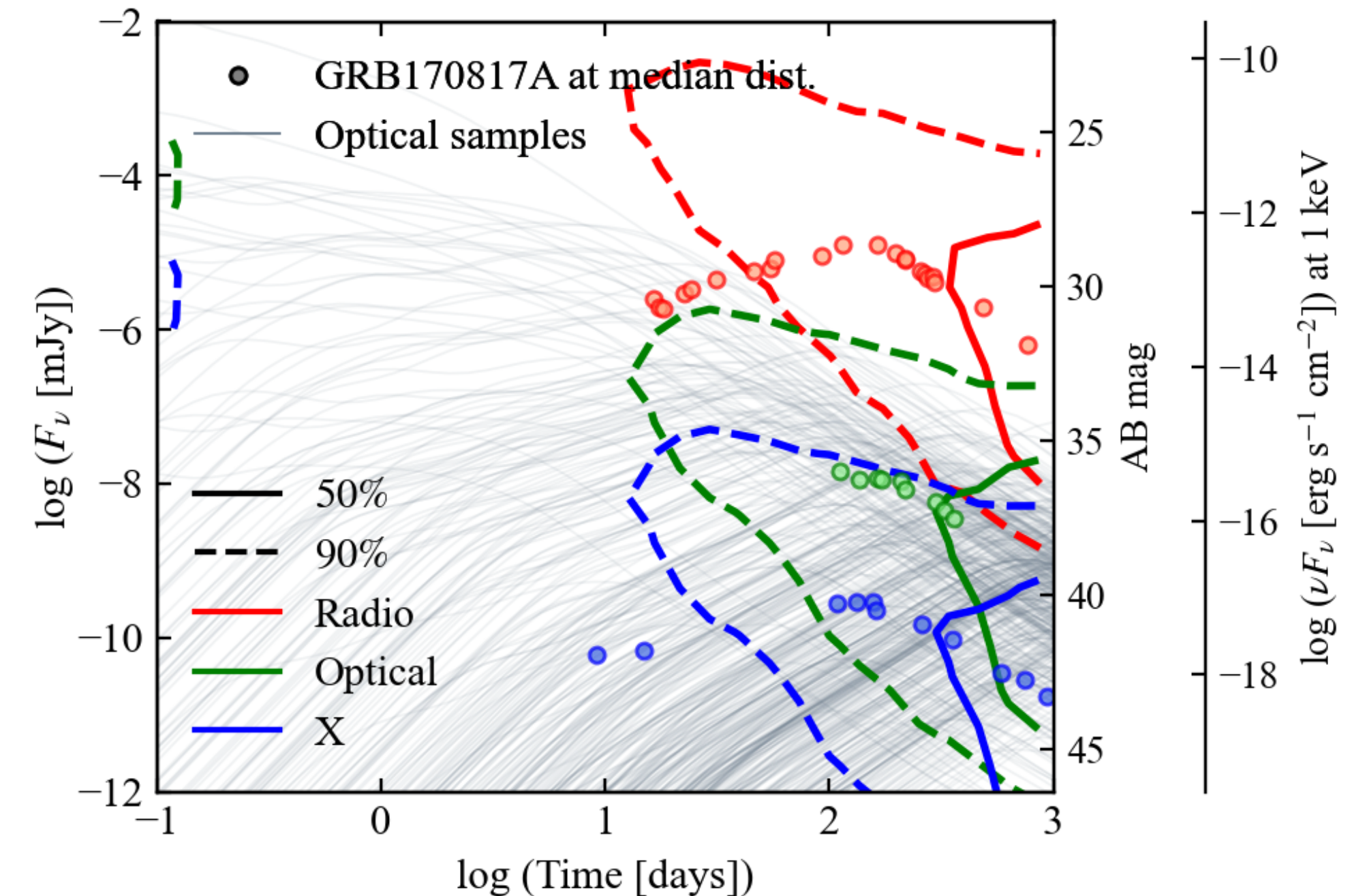


OSB - Div7 (Bizouard, Cappellaro  $\rightarrow$  Limongi, Cerda-Duran)

Stellar Collapse and Isolated Neutron Stars

- Theoretical Models
- Data analysis
- MM Observational strategies

Colombo, Salafia, et al. 2023

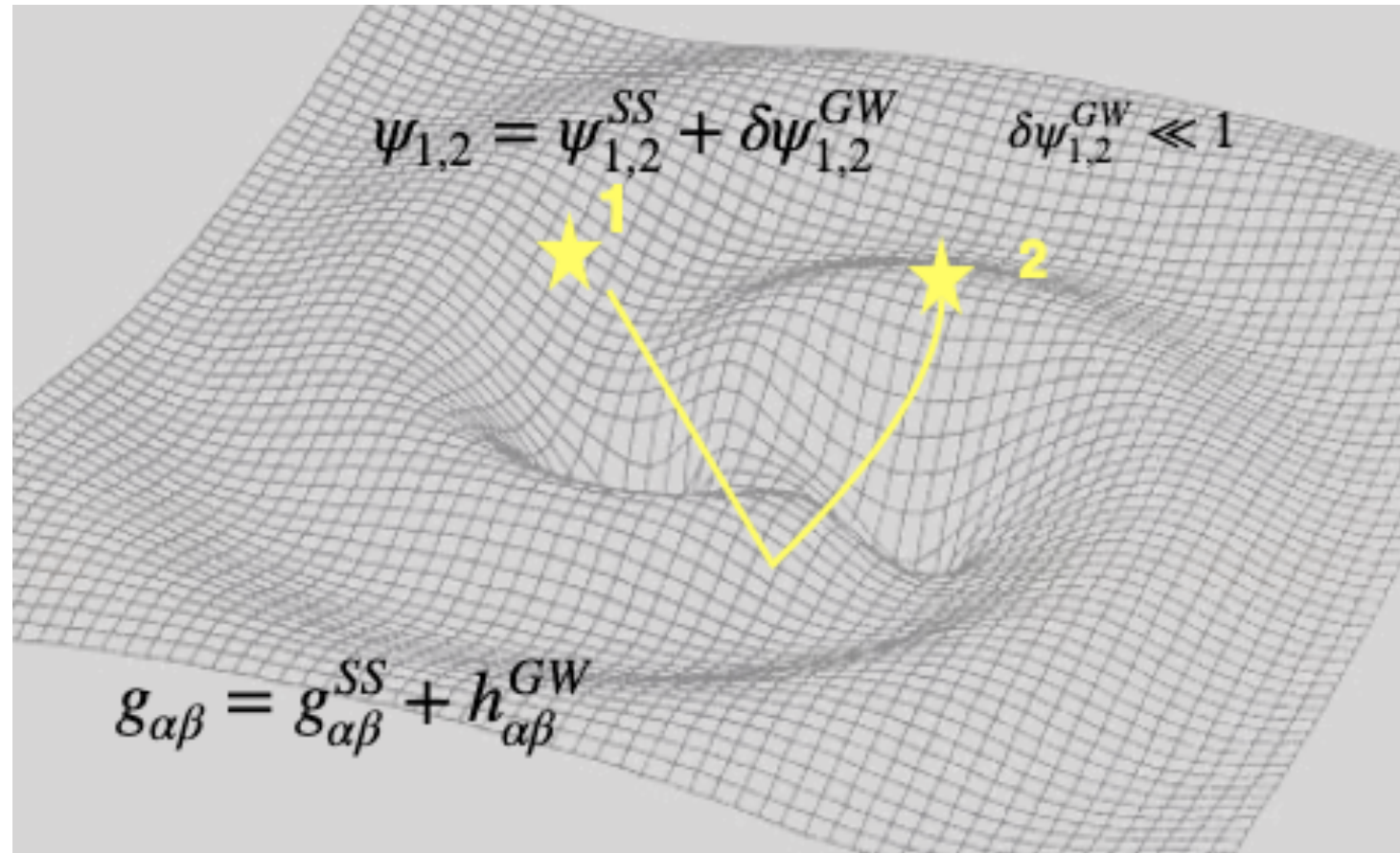


OSB - Div4 (Vergani, Ghirlanda, Levan)

Multi Messenger Observations

- Simulation of EM signals (from CB mergers)
- How to catch and study them (facilities / strategies)

# INAF Scientific contributions



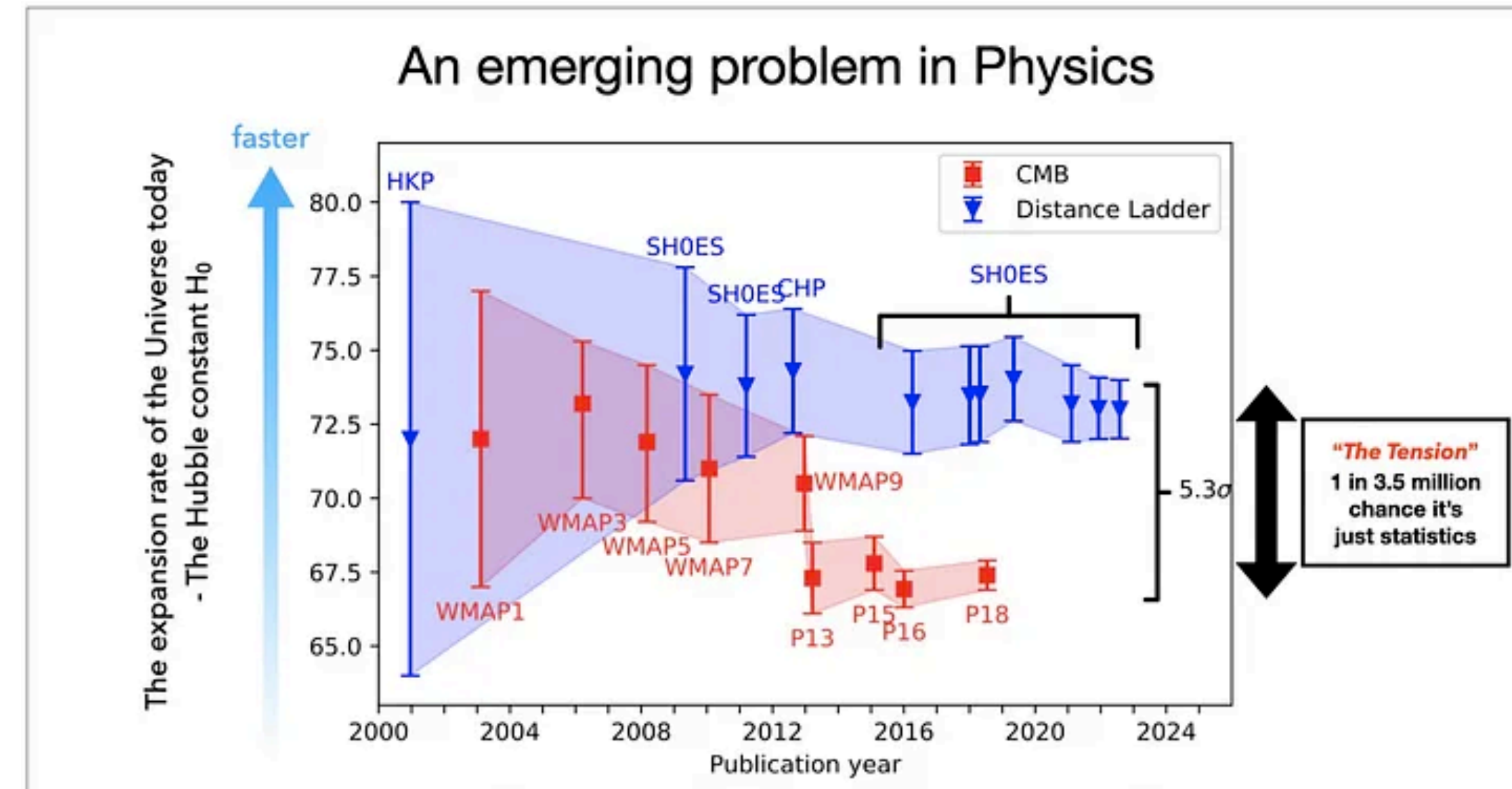
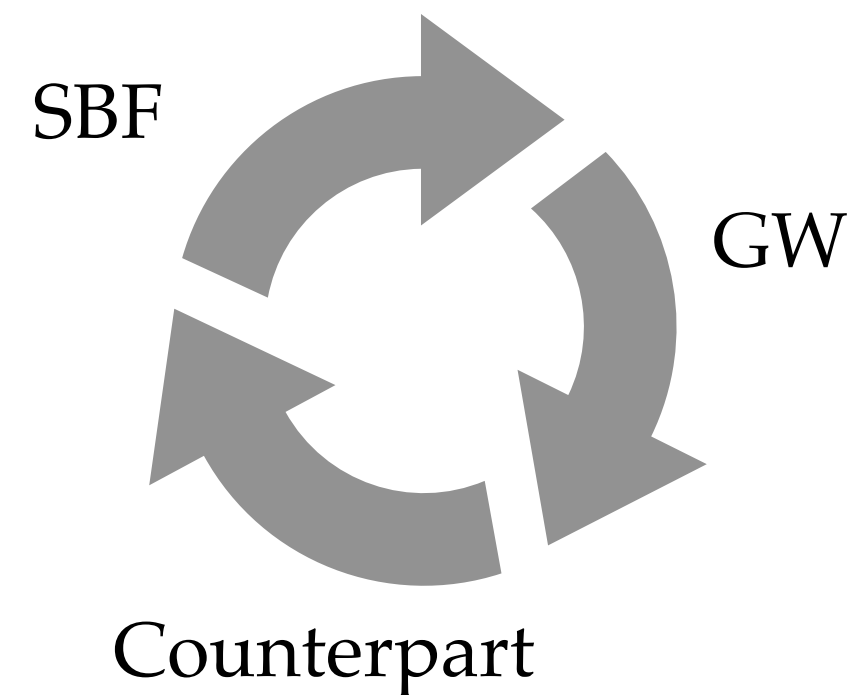
ASTROmetric GRAvitational Wave ANTenna (RU2 INAF Torino - **Crosta**)

GAIA  $\rightarrow$  complement ET

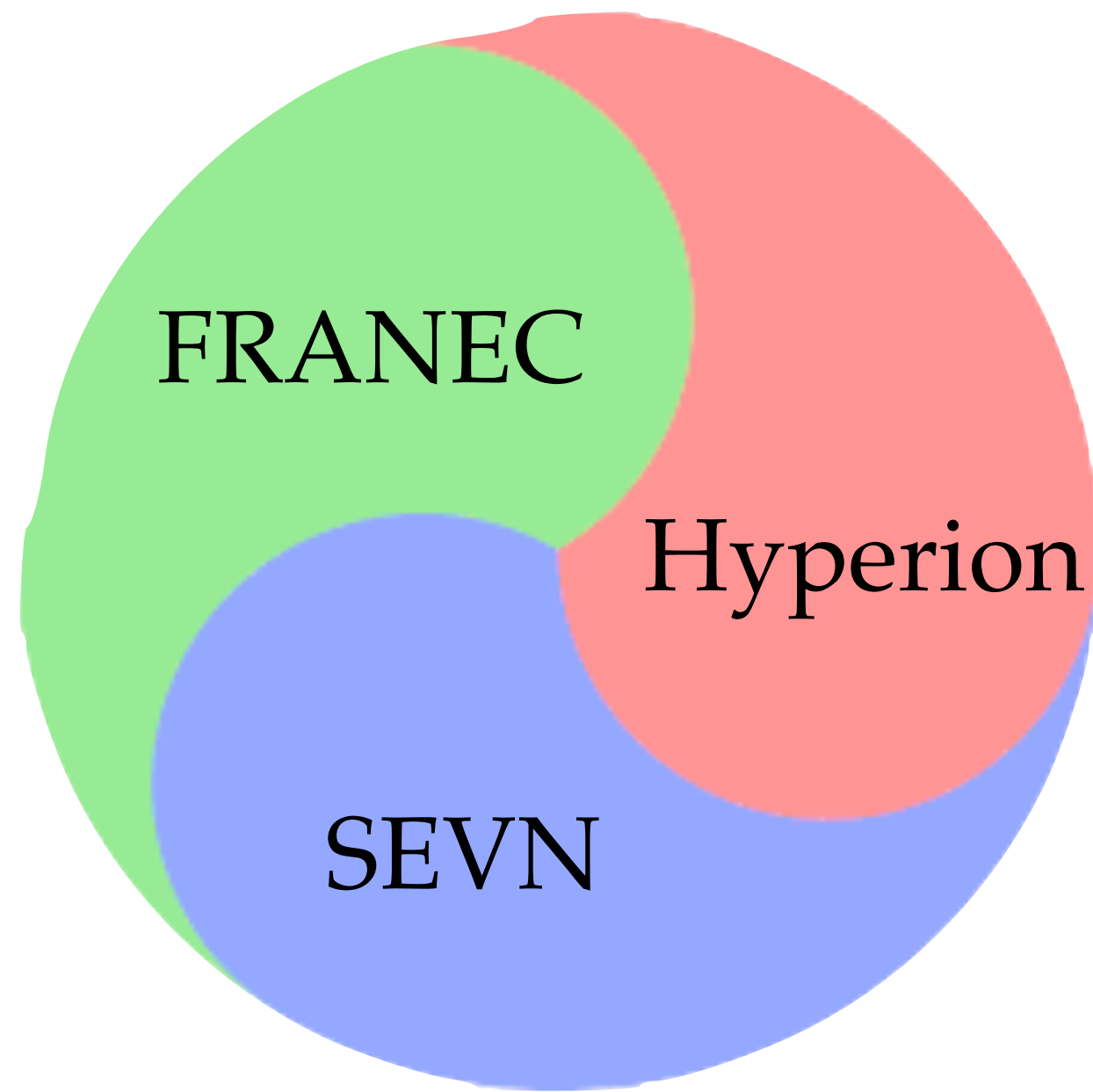
Study of possible auxiliary space/ground based observatories to complement ET (GW sentinel)

Cosmological constraints (**Cantiello** et al. )

- Methods (SBF)
- Precision
- Complementarity



STARLIGHT (INAF+SISSA+UNI ... - **Limongi**)

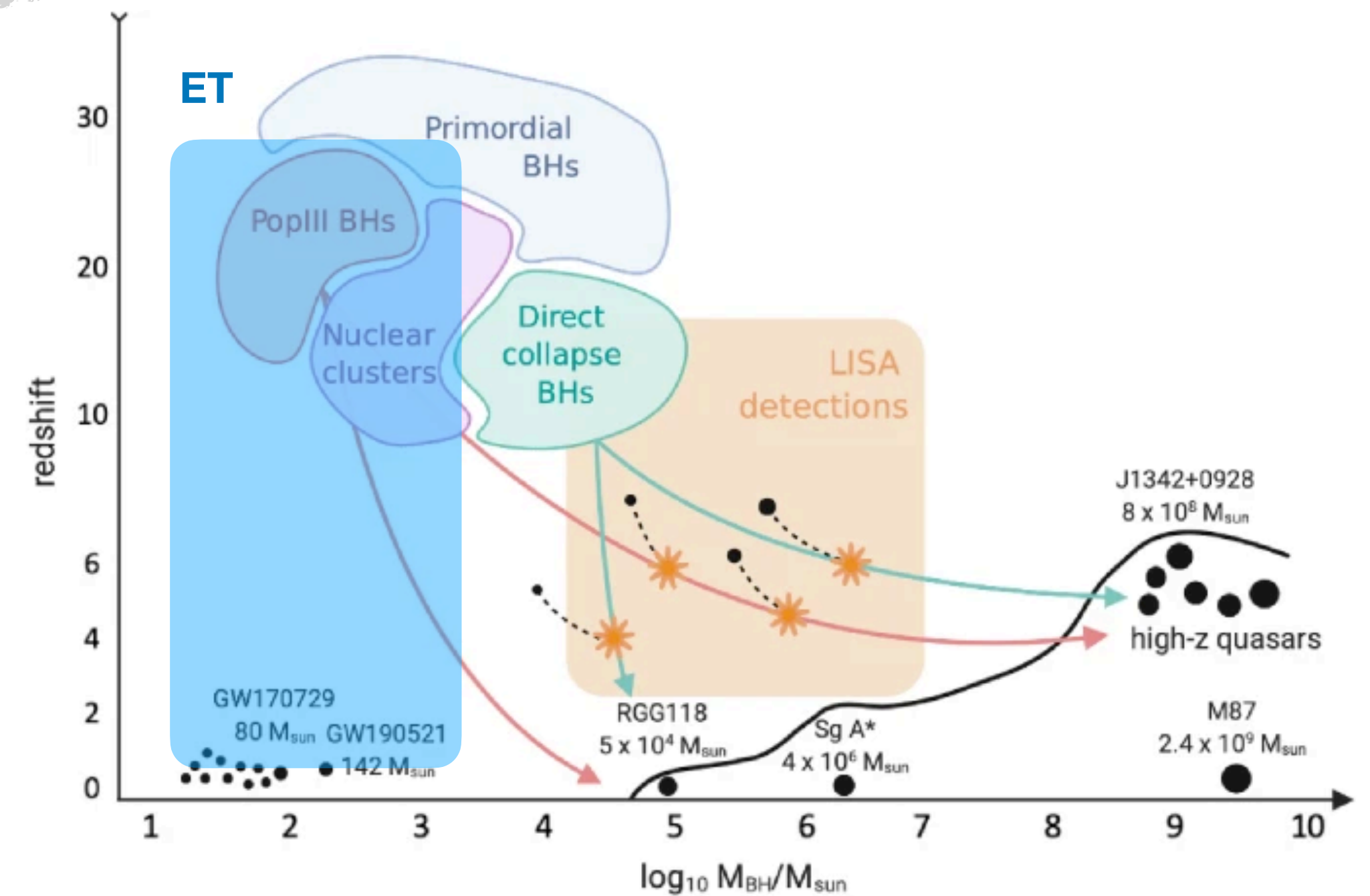


Models for evolution (FRANEC) + explosion (Hyperion) of intermediate mass stars within population synthesis codes (SEVN)

- Predictions
- MM syneriges
- Data analysis

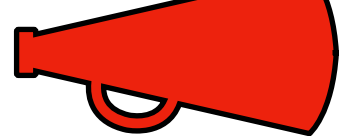
SMBH formation channels - a Multi-messenger approach  
(**Mannucci** et al. )

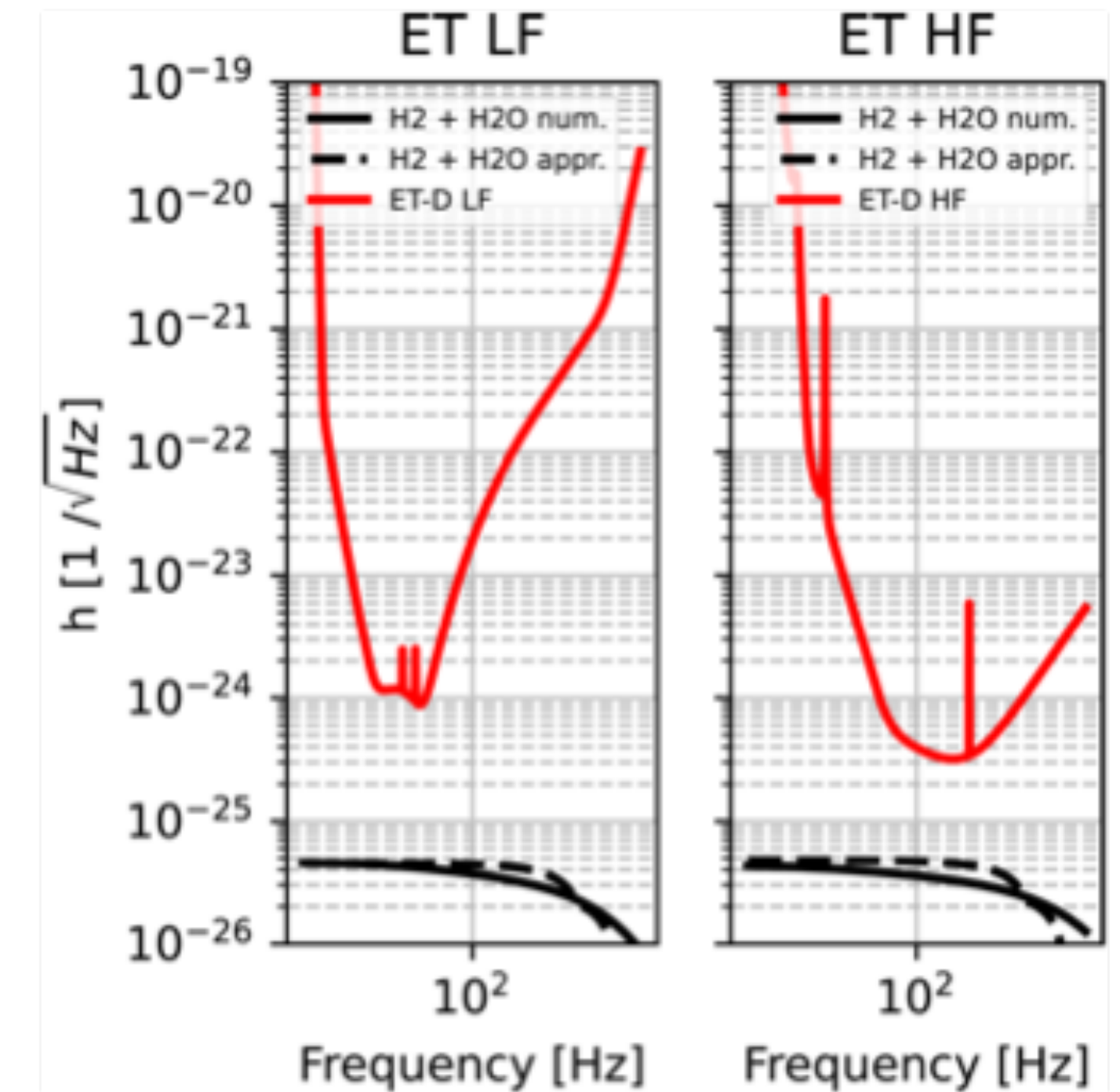
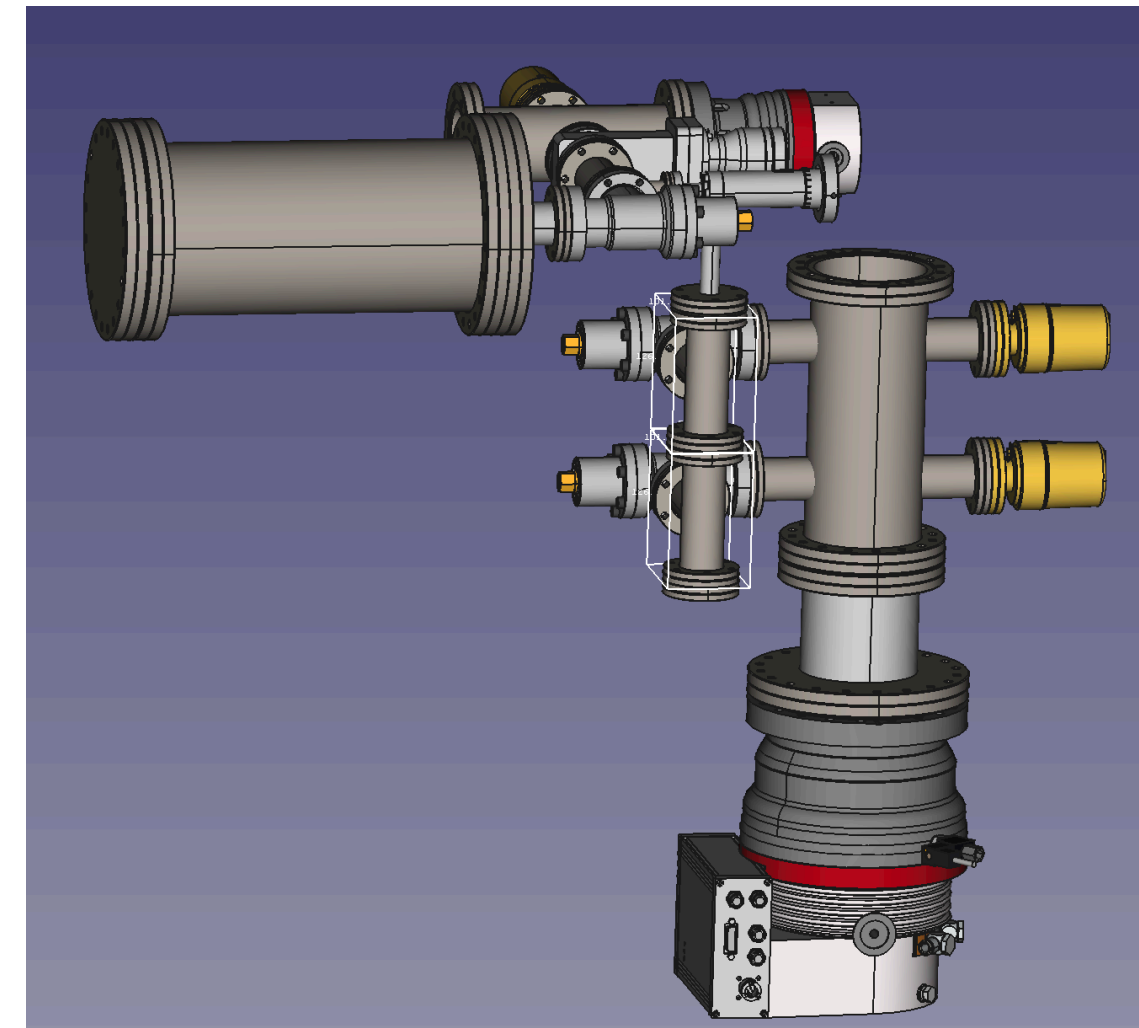
EM (IR/X-ray) probe accretion physics of the parent population



# INAF Technological contributions

ETIC (PNRR)  
[E.Cappellaro]

- ADONI (Esposito) 
- IdroC cont. (Mennella)
- Vacuum pipe material (Grado)



ETIC project: Study of hydrocarbon contamination on surfaces in UHV systems

Set up of a degassing station at the Astronomical Observatory in Naples to study materials for the beampipe

– A. Grado, V. Mennella, F. Cozzolino, L. Limatola, F. Getman, E. Zona



# INAF projects relevant for ET

**$\gamma$ -rays**

## cta Cherenkov Telescope Array

- 4 Large (+2 INAF) (23m)
- 25 medium (12m)
- 37 small (5m)



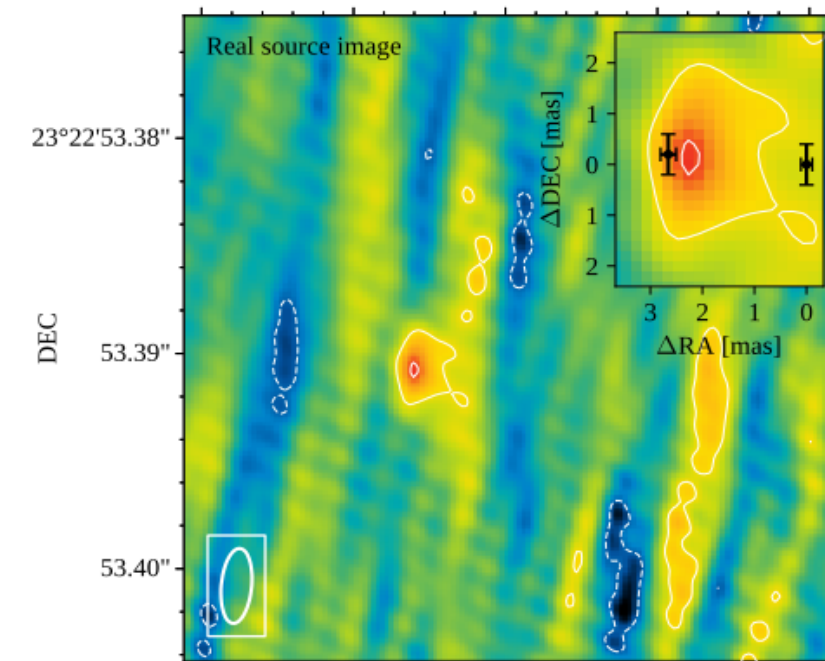
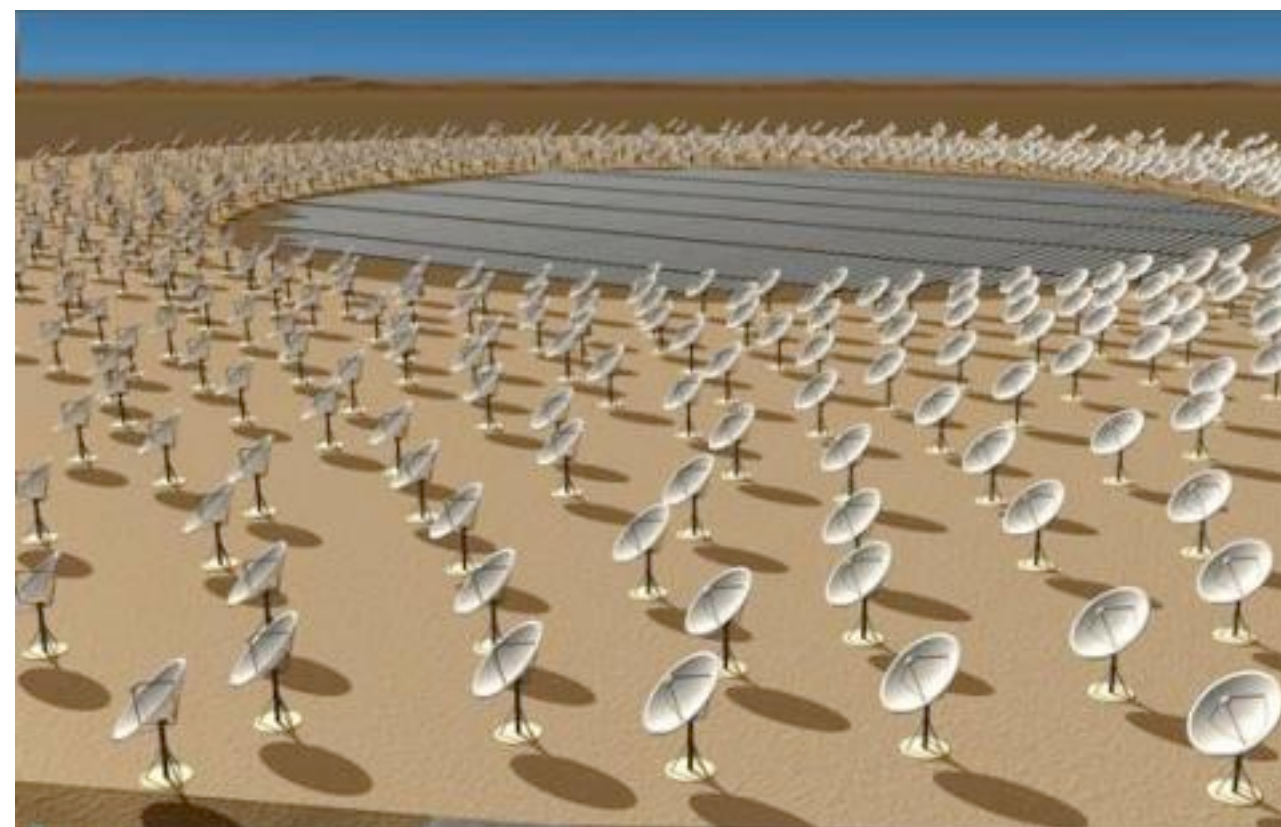
Unique search capabilities  
Unique characterisation



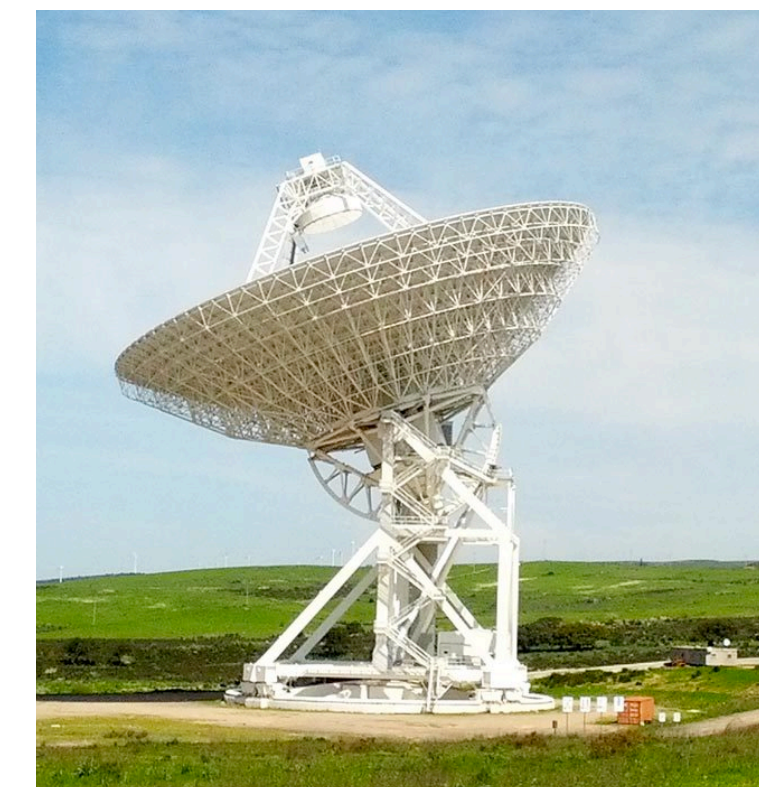
## Square Kilometer Array

Benefit of ET pre-merger alerts

**Radio**



## INAF radio telescopes



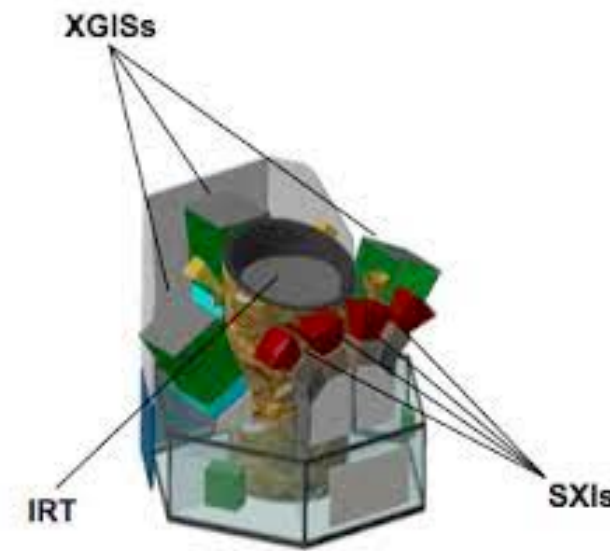
# INAF projects relevant for ET

X- $\gamma$ -rays (space)



ESA M7 (+ASI) (INAF P.I. **L. Amati**)  
 INAF PI/Co-ship of 2/3 detectors

Discovery & localisation of X/ $\gamma$  ray counterparts + KN studies



HERMES  
 (INAF P.I. **F. Fiore**)

“Distributed architecture”



Search machine

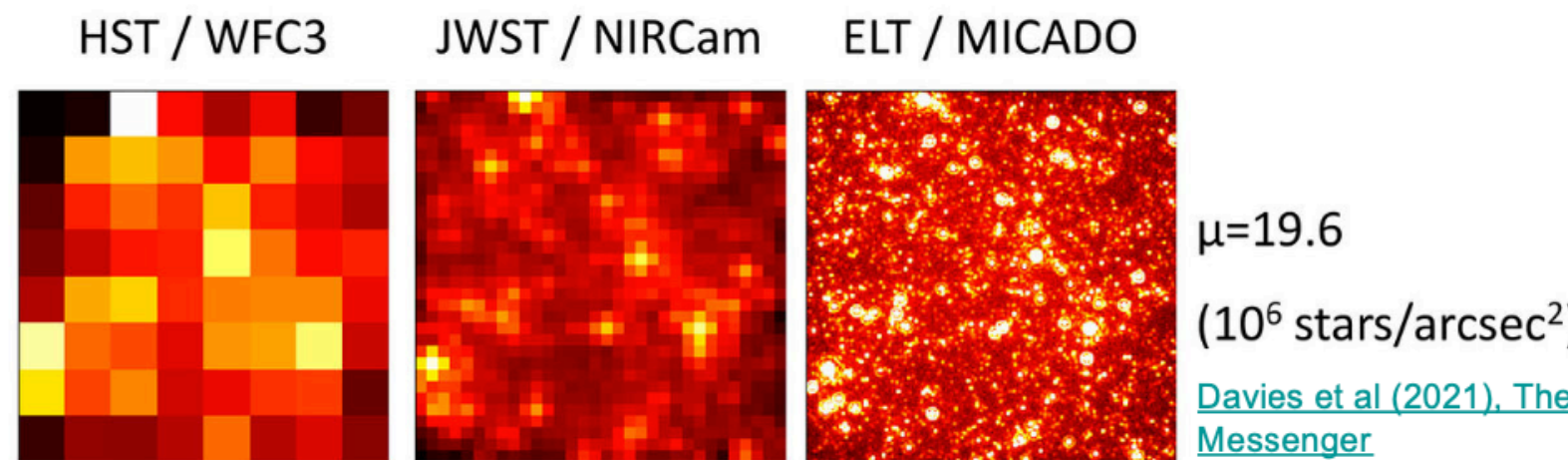
Optical / NIR



ELT  
 (Extremely  
 Large  
 Telescope)

>2027

$\varnothing=39\text{m}$

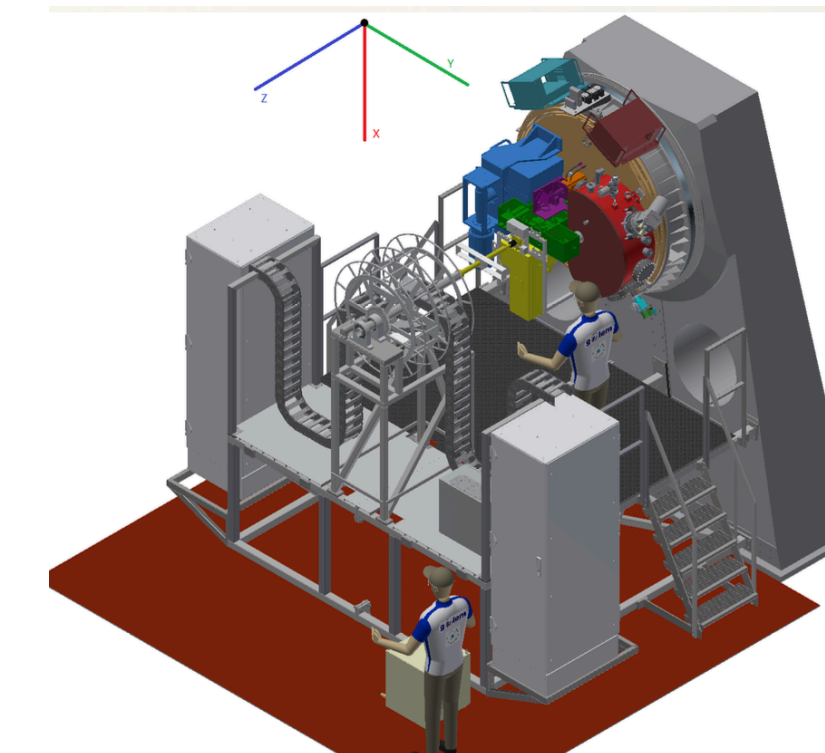


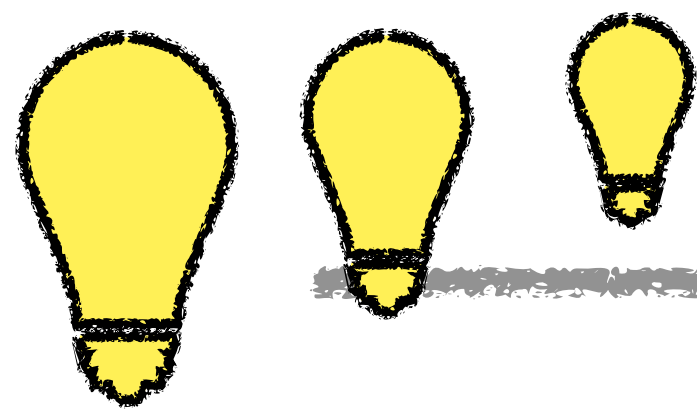
MAORY (INAF)

HIRES (INAF)

>100 GTO nights @ INAF

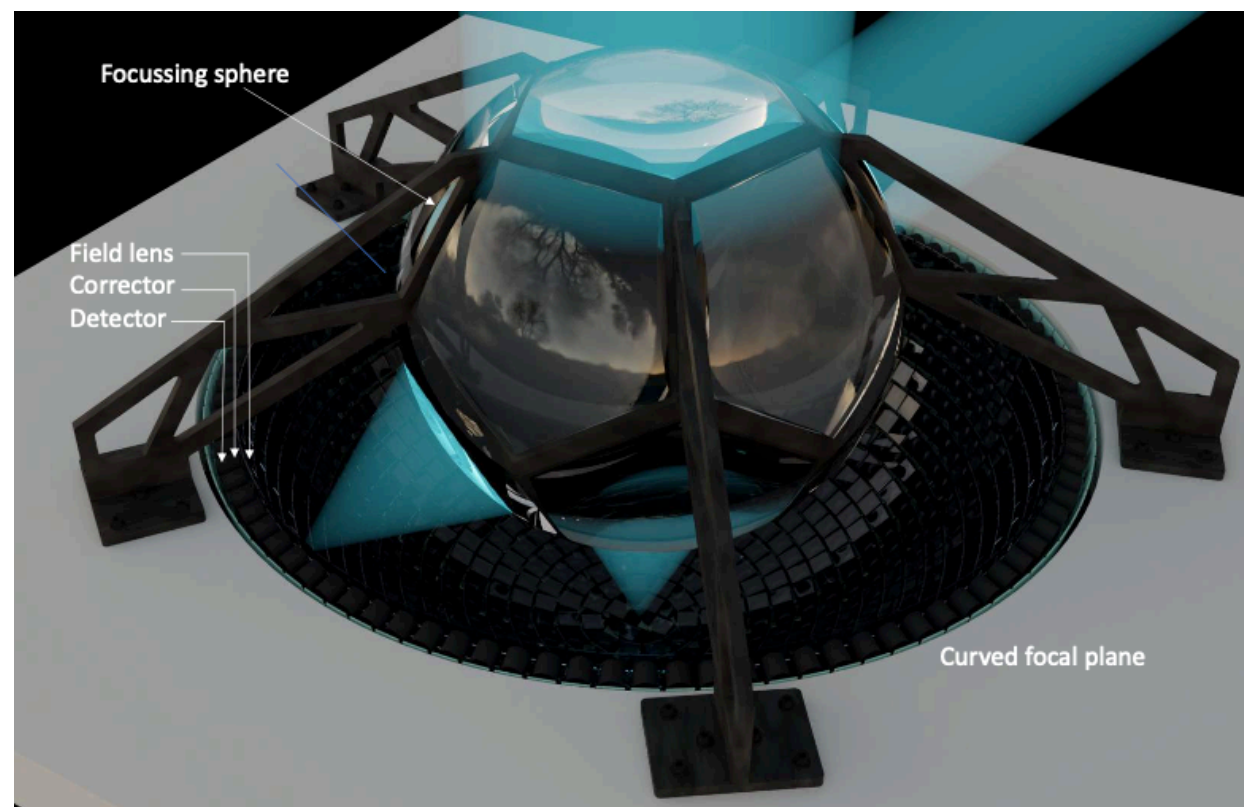
SoXS (**Campana, S.**)





# INAF ... thinking tank

MezzoCielo (INAF - **R. Ragazzoni**)

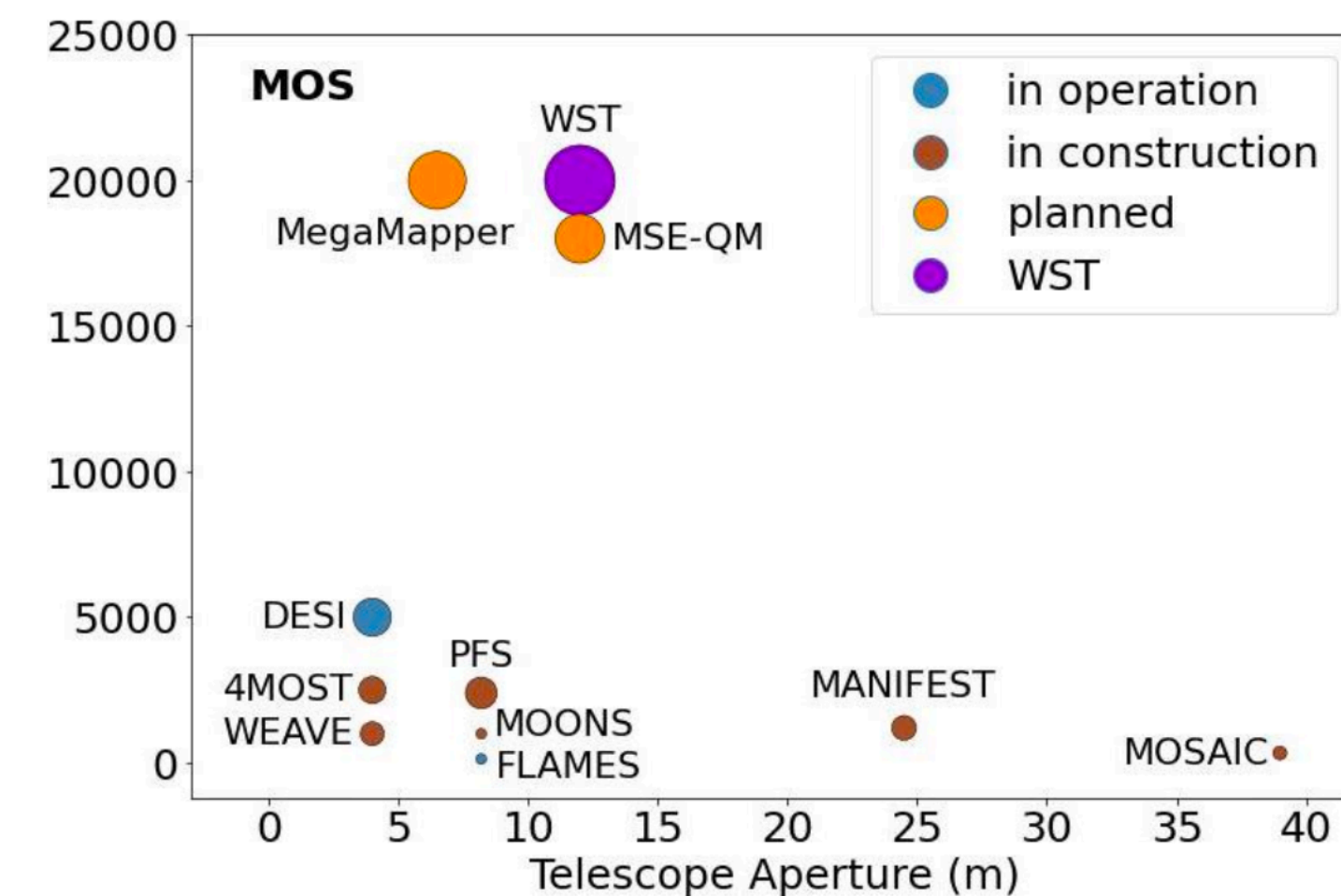


HUGO (High-z Universe Grb Observatory)  
(INAF - **S. Campana**)

INAF - **Randich, Schipani, Garilli, ...**



VRO



# Conclusions

Einstein Telescope: Numeri, Distanze, Sorprese



INAF = Astrofisica (Scienza, Tecnologia, Formazione ...)

Contributo: RU, OSB, EIB ...

INAF = Telescopi / Satelliti (Utilizzo, Gestione,  
Programmazione, Costruzione, Analisi dati)