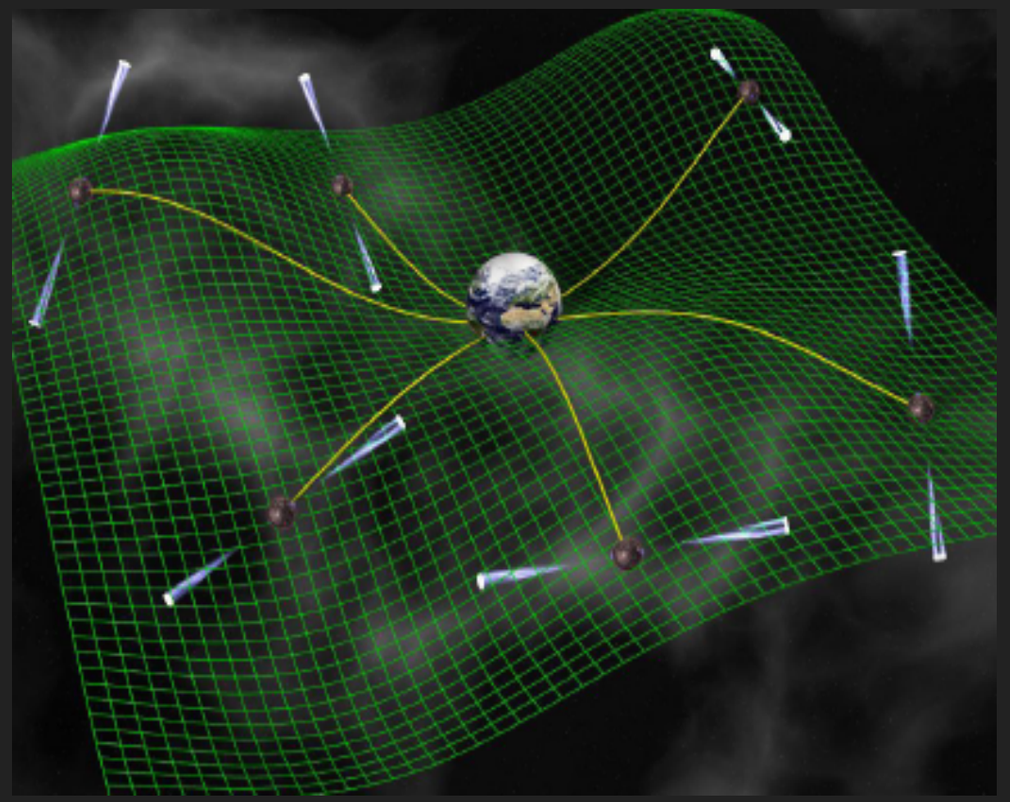


D. Champion

DELPHINE PERRODIN — INAF OSSERVATORIO ASTRONOMICO DI CAGLIARI

WITH M. BURGAY, A. CORONGIU, A. POSSENTI, A. SESANA, M. CROSTA

PULSAR TIMING ARRAYS AND THE SKA

STUDY OF PULSARS: TOP SCIENCE GOAL FOR SKA

Priority SKA Science Cases for SKA-1

Pulsar Timing Arrays for GW detection appear in two science cases

- 4- Reveal pulsar population and MSPs for gravity tests and Gravitational Wave detection
- 5- High precision timing for testing gravity and GW detection

Detect GW with regular timing of

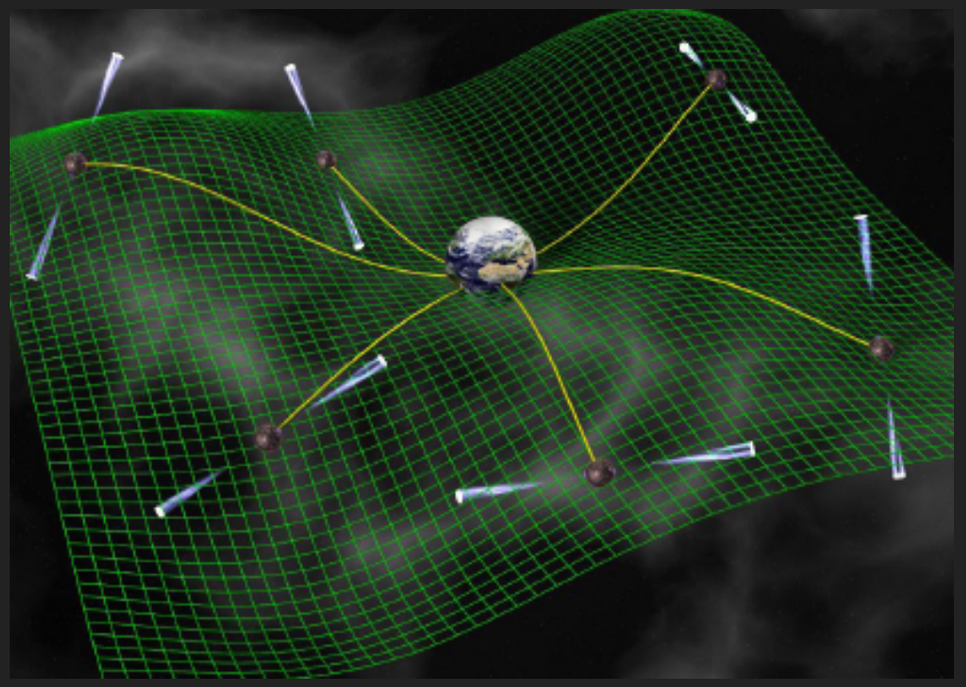
large number of millisecond pulsars

PULSAR TIMING ARRAYS FOR GW DETECTION

Pulsar Timing Arrays (PTAs) use millisecond pulsars (MSPs) and Earth as test masses.

GWs affect the space-time between Earth and pulsars, introducing offsets in pulsar times-of-arrival (TOAs).

- PTAs sensitive to nHz GWs from supermassive BH binaries and cosmic strings
- PTAs monitor timing residuals of MSPs over 10-30 years
- Detection achieved by studying correlation of residuals between different pulsars



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INTERNATIONAL PULSAR TIMING ARRAY (IPTA)

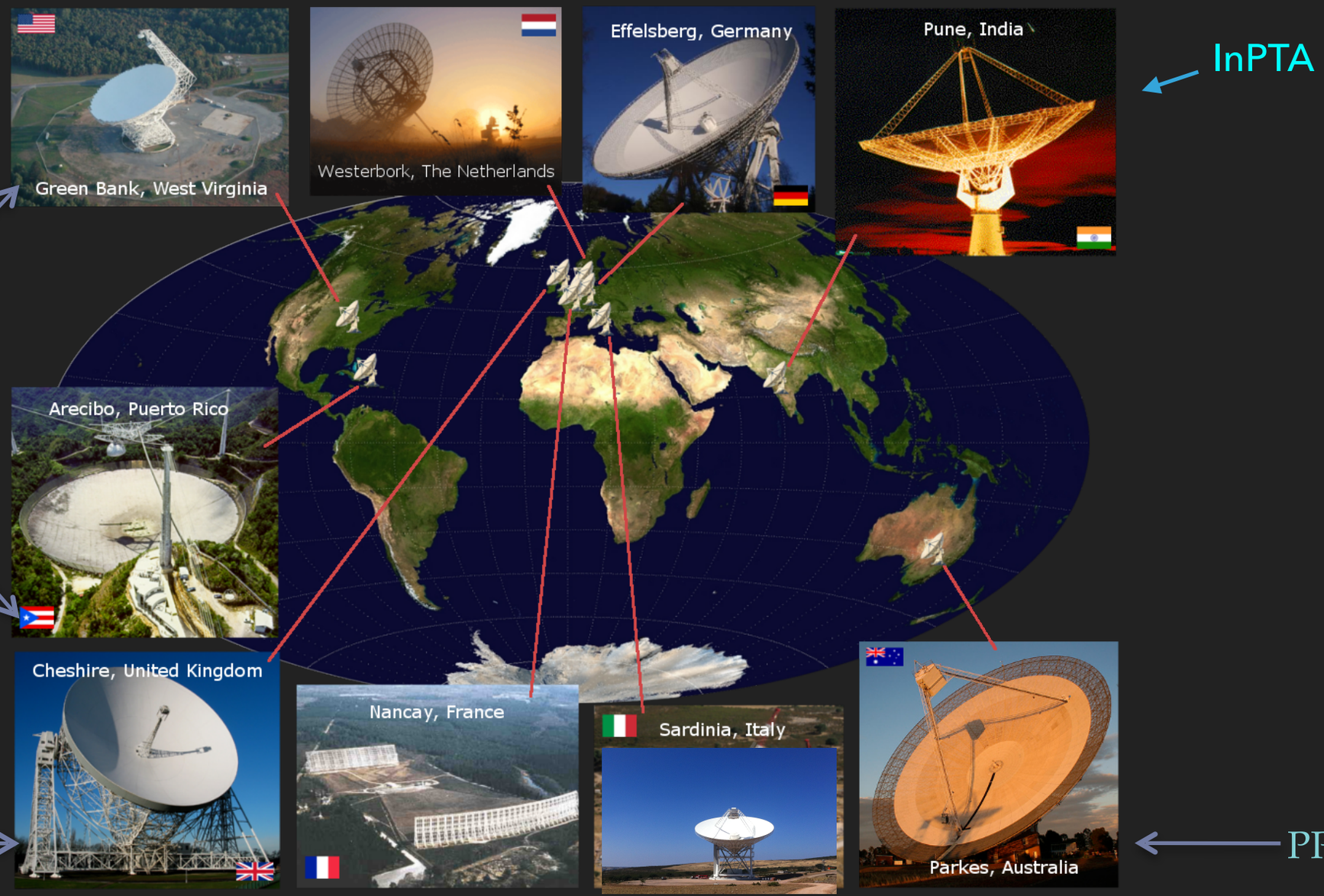


Image source, clockwise from upper left: http://www.gb.nrao.edu/; http://www.astron.nl/; http://www.mpifr-bonn.mpg.de/english/index.html; http://gmrt.ncra.tifr.res.in/; http://www.flickr.com/photos/shami_chatterjee/455275921/; http://www.srt.inaf.it/; http://www.obs-nancay.fr/; http://www.jb.man.ac.uk/; http://www.naic.edu/

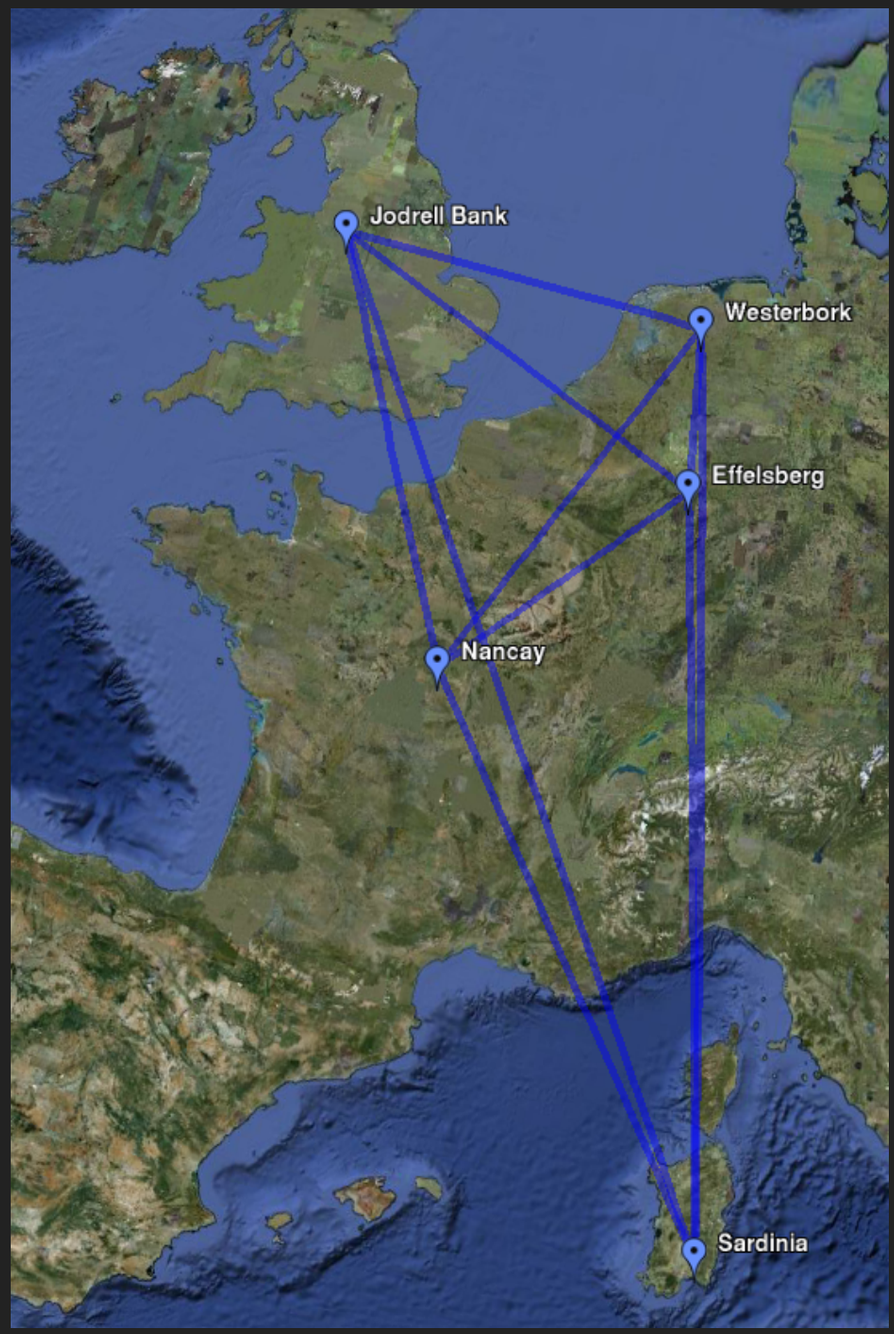
EUROPEAN PULSAR TIMING ARRAY (EPTA)

The Sardinia Radio Telescope (SRT) is the latest addition to the European Pulsar Timing Array (EPTA)

and to the Large European Array for Pulsars (LEAP) project that performs simultaneous observations at all 5 EPTA telescopes

LEAP has the same sensitivity as SKA-1

Located south of other EPTA telescopes, SRT can observe more southern pulsars such as J1909-3744



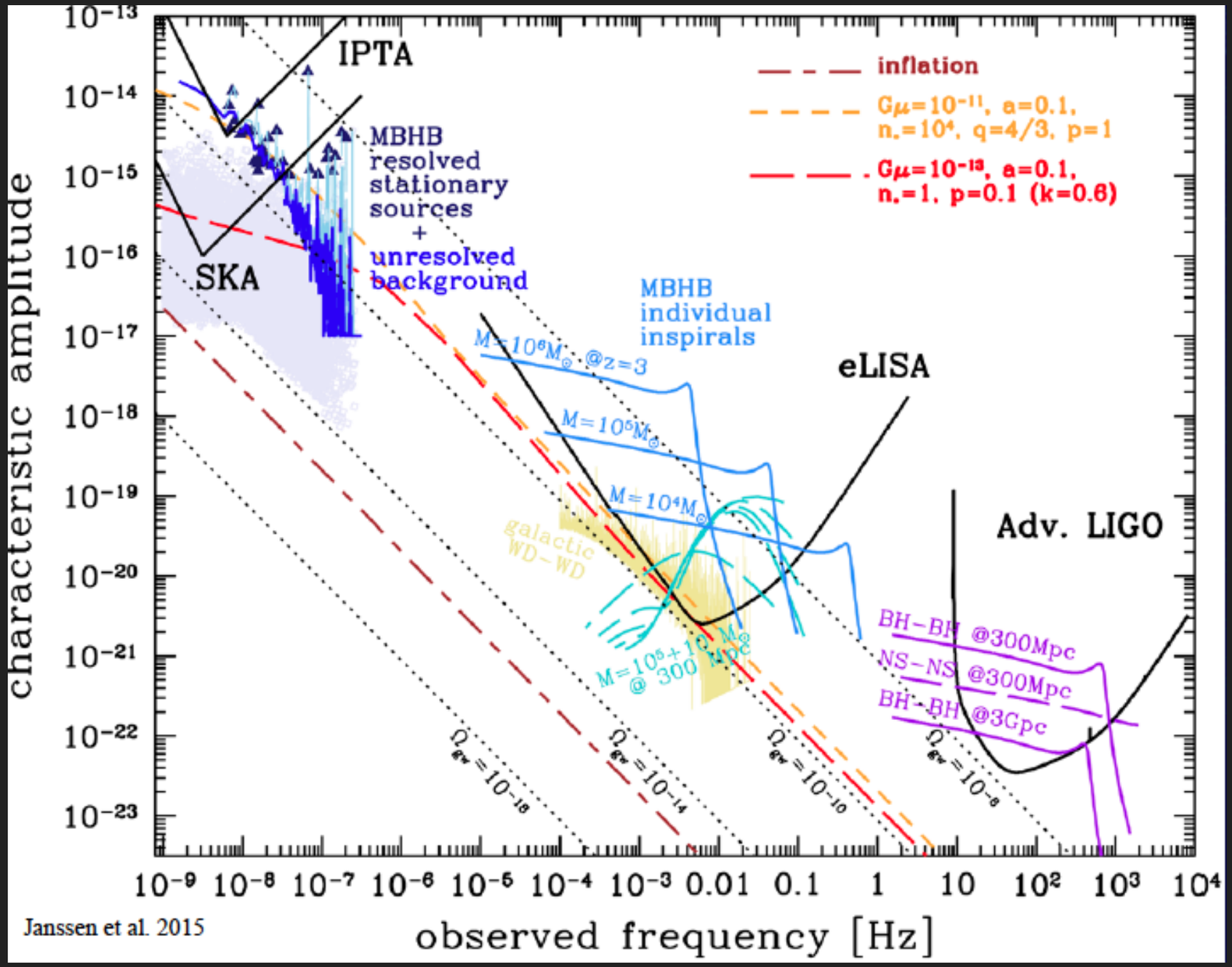
THE SARDINIA RADIO TELESCOPE (SRT)

- Fully-steerable 64-m diameter dish
- 3 main focal positions
- Can host 20 receivers
- Wide frequency range (300 MHz to 115 GHz)
- Active surface
- Dual L/P band receiver

SRT Sardinia Radio Telescope

INAF ISTITUTO NAZIONALE DI ASTROFISICA NATIONAL INSTITUTE FOR ASTROPHYSICS

PTA: COMPLEMENTARY TO LIGO AND LISA

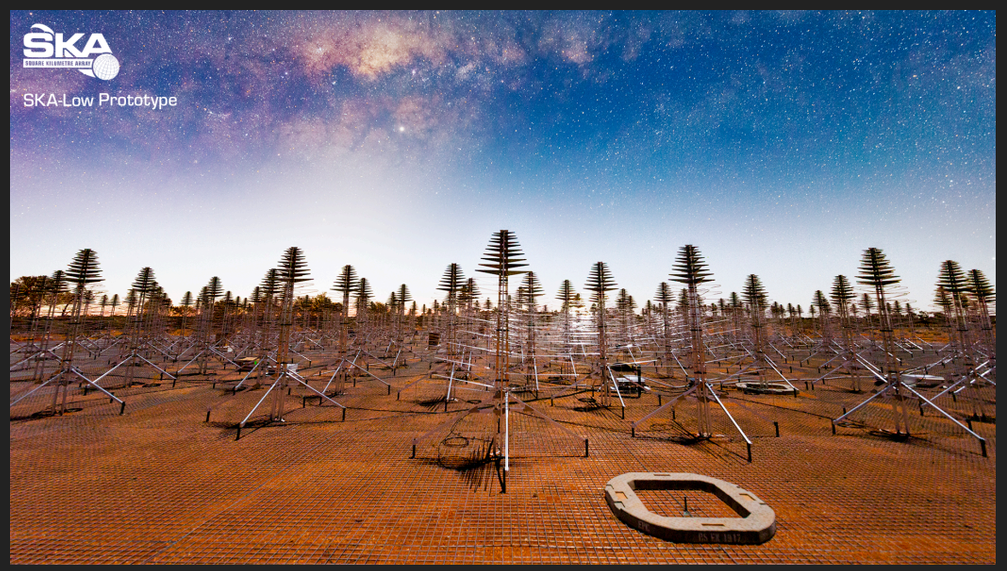


PTAs: frequencies in nanohertz regime

Corresponds to timelines of ~1-30 years

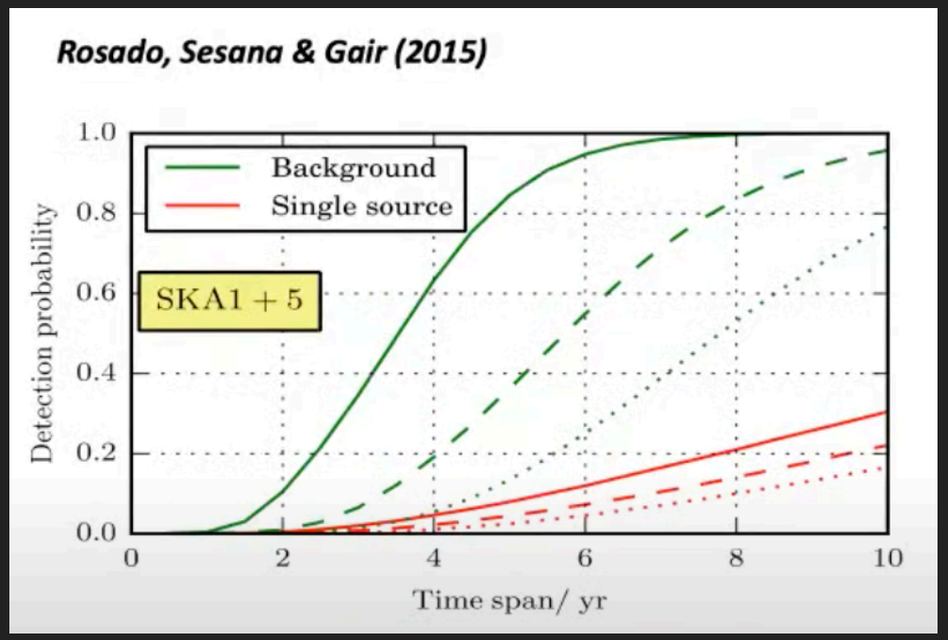
SKA: FINDING NEW PULSARS

- Pulsar surveys with SKA-1will reveal large new population of millisecond pulsars (MSPs)
- ~700-900 new MSPs with SKA-mid
- ~400-900 new MSPs with SKA-low



SKA: TIMING PULSARS

- Pulsar timing at SKA1-Low: 16 independent beams + 300 MHz bandwidth
- Pulsar timing at SKA1-Mid: 16 independent beams, 2 GHz per beam, up to 20 GHz using multiple beams. Coherent de-dispersion up to 3000 cm^-3 pc.
- With SKA-Mid, high-precision timing of many known MSPs for GW detection Simulations are promising
- Expected time to detection with SKA: within 2 to 6 years



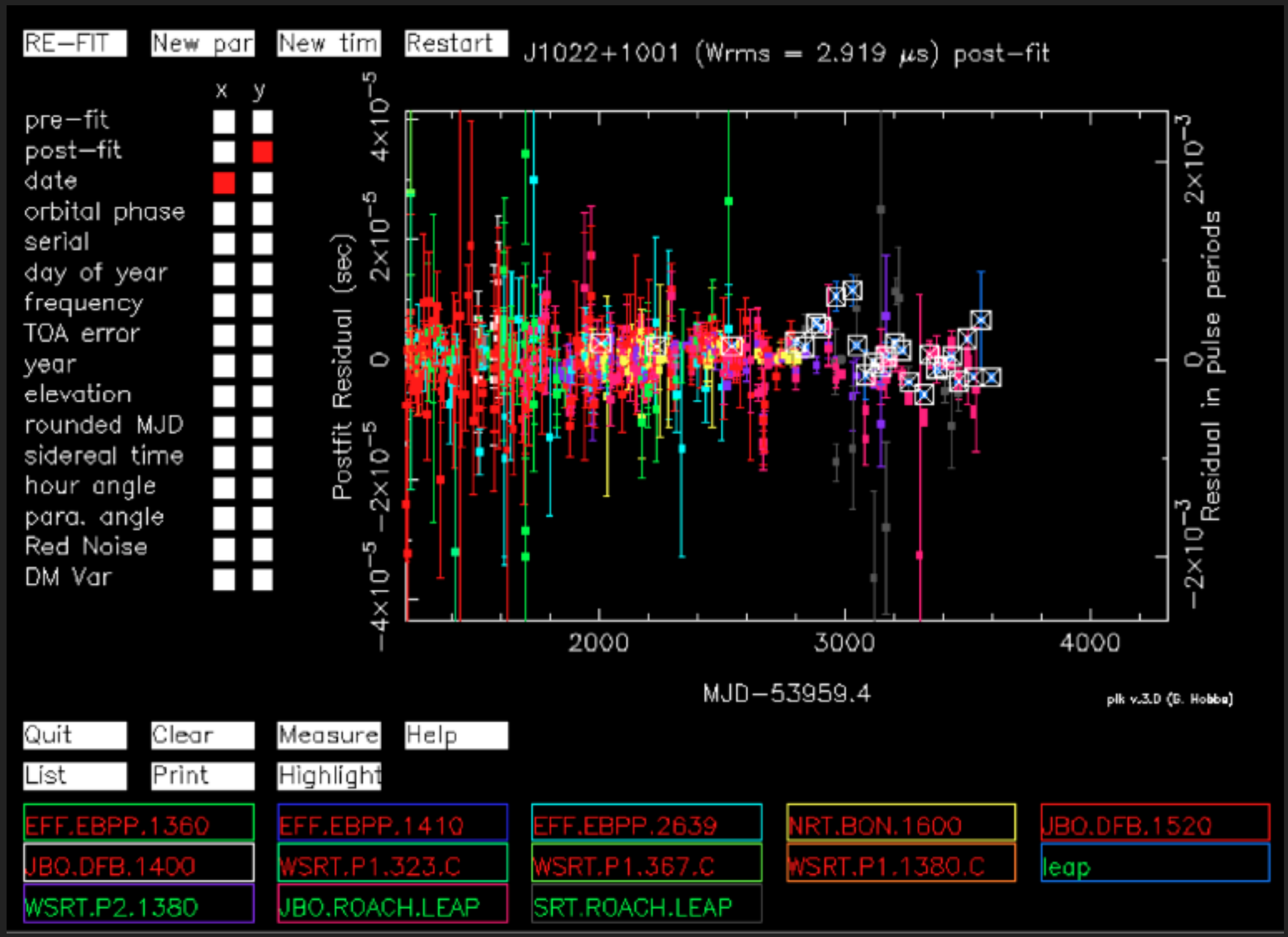
50 pulsars @ 100 ns + 5 @ 10 ns

MeerTime: 80 pulsars @ 1 mcs + 5 @ 100 ns

SKA: TIMING PULSARS

- Build on current MeetKAT capabilities and MeerTime pulsar timing program: very encouraging results for future SKA-1 capabilities
- Pulsar timing data from MeerKAT and SKA will be merged with those of the International Pulsar Timing Array (IPTA)
- SKA southern position is strategic and complements other PTA telescopes around the world

COMBINATION OF TIMING RESIDUALS



SKA: PTA EXPERTISE IN ITALY

- PTA expertise: observing, data reduction, data combination and GW data analysis
- Members of EPTA and LEAP and operators/users of the SRT, experience with commissioning of telescope and instrumentation
- Expert users of MeerKAT and members of MeerTime
- Contribute to IPTA working groups: observing strategy, data combination, detection, SKA observing, instrumentation, data preparation
- Members of SKA working groups on pulsars
- Theoretical GW expertise at University Milano-Bicocca (A. Sesana's group)
- Combining PTA and Gaia data at INAF-Torino (M. Crosta's group)
- Italy in a strategic position to develop SKA capabilities for pulsars and to exploit future SKA PTA data for GW detection

CONCLUSION

- SKA1 surveys will greatly increase number of millisecond pulsars
- SKA1 high-precision timing program could lead to GW detection within 2 to 6 years
- Early results from MeerKAT are very encouraging
- Lead to GW detection as well as characterisation
- Expertise in Italy with observing pulsars, data reduction, data combination and GW data analysis of PTA products will be extremely valuable for the exploitation of SKA data