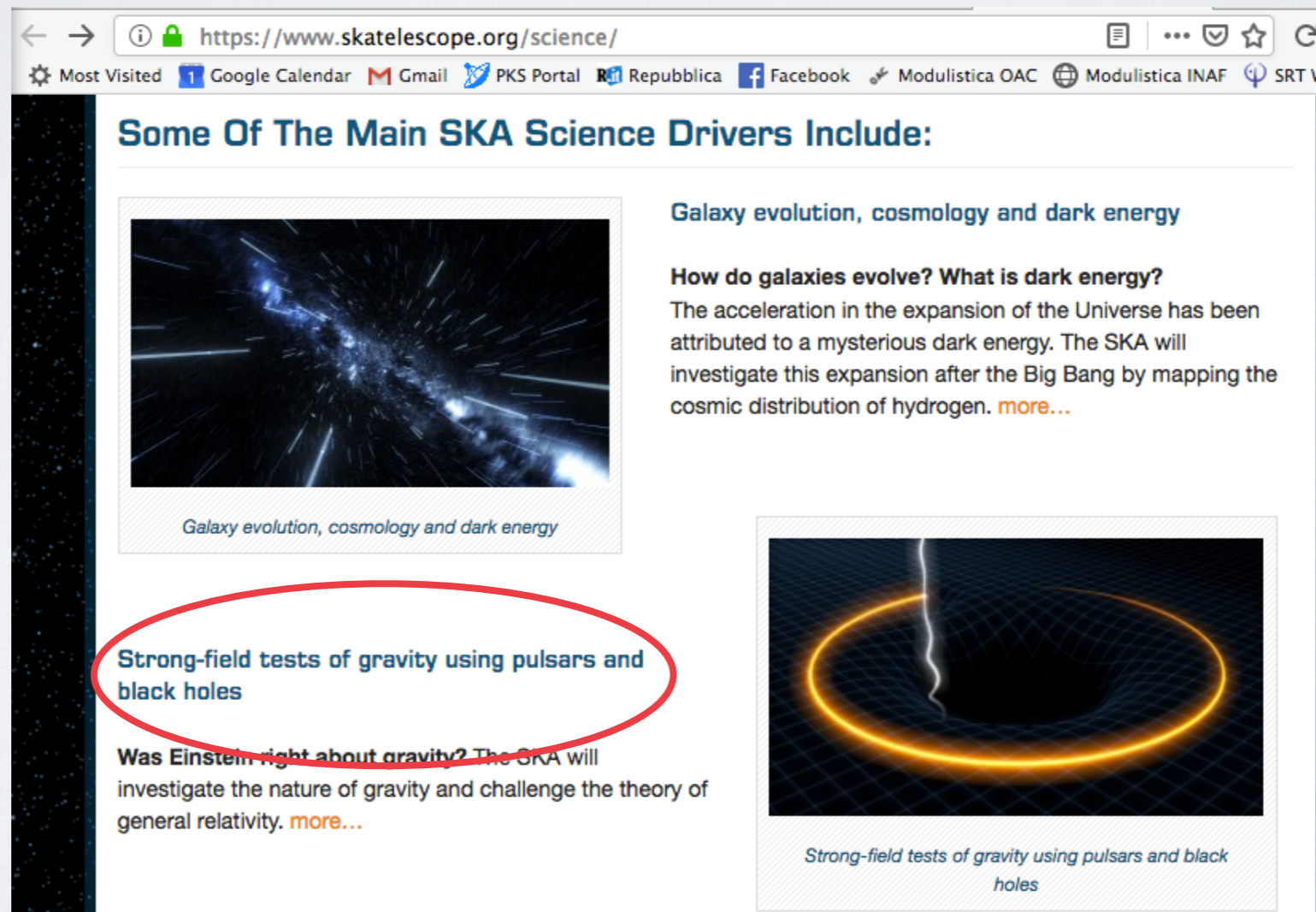


PULSARS WITH MEERKAT

INAF involvement towards the SKA

PULSARS IN THE SKA CONTEXT

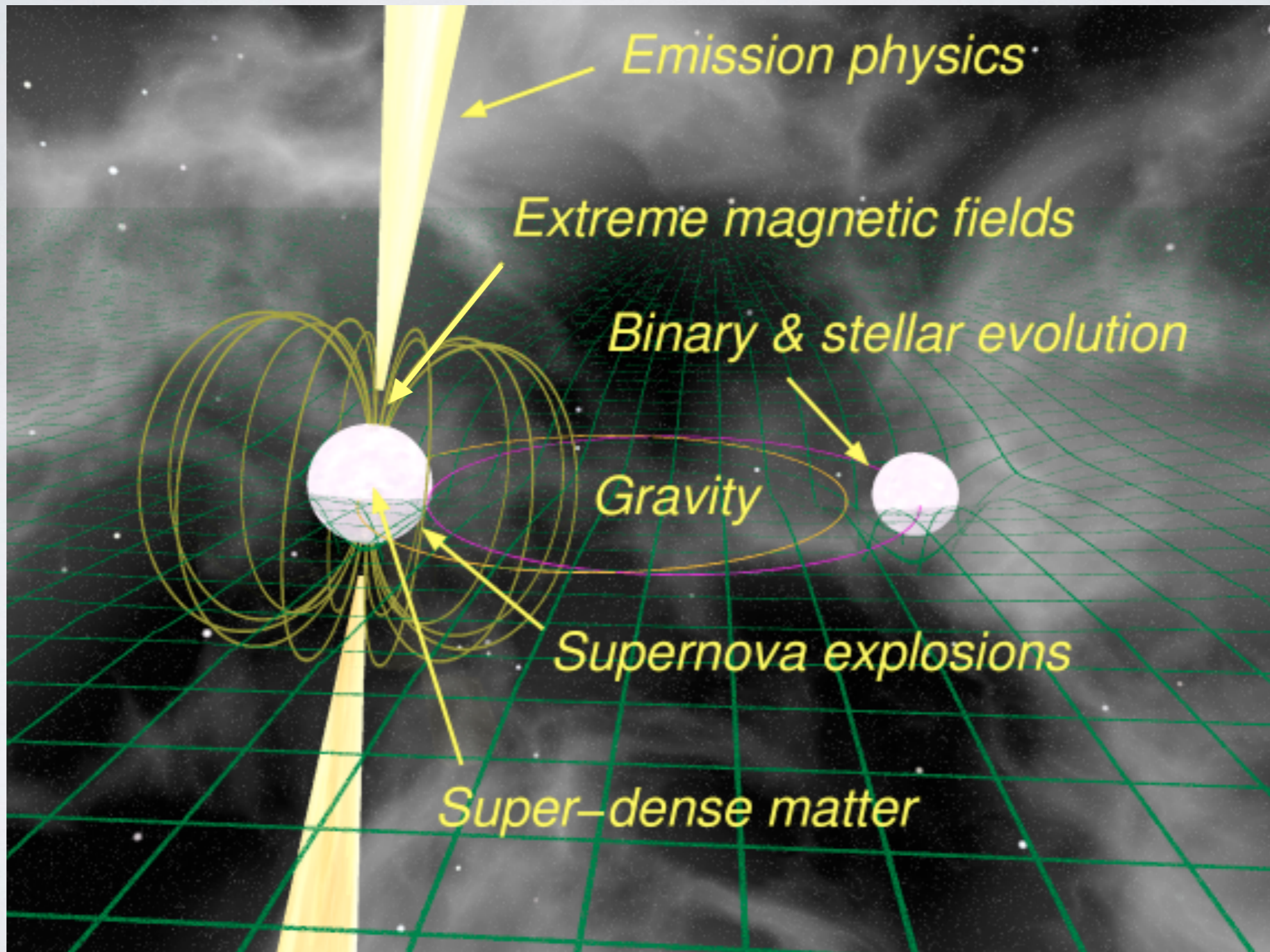
- Pulsars (and Fast Radio Bursts) are among the Main Science Drivers for the SKA




The screenshot shows a web browser window with the URL <https://www.skatelescope.org/science/>. The page title is "Some Of The Main SKA Science Drivers Include:". There are three main sections:

- Galaxy evolution, cosmology and dark energy**: Accompanied by an image of a galaxy cluster. Text: "How do galaxies evolve? What is dark energy? The acceleration in the expansion of the Universe has been attributed to a mysterious dark energy. The SKA will investigate this expansion after the Big Bang by mapping the cosmic distribution of hydrogen. [more...](#)"
- Strong-field tests of gravity using pulsars and black holes**: This section is circled in red. Text: "Was Einstein right about gravity? The SKA will investigate the nature of gravity and challenge the theory of general relativity. [more...](#)"
- Strong-field tests of gravity using pulsars and black holes**: Accompanied by an image of a black hole. Text: "Strong-field tests of gravity using pulsars and black holes"

THE SCIENTIFIC IMPACT OF PULSARS



PULSARS WITH THE MEERKAT

 SKA AFRICA
SQUARE KILOMETRE ARRAY

[Home](#) [About](#)

Rank-ordered list of approved MeerKAT Large Survey Projects :

1. MeerTime (binary)
2. MHONGOOSE
3. MeerTime (MSPs)
4. LADUMA
5. Fornax
6. TRAPUM (Fermi sources)
7. MeerTime (1000 PTA)
8. ThunderKAT (CVs)
9. MIGHTEE (L band)
10. ThunderKAT (GRBs)
1. MeerTime (GCs)
12. MALS (UHF and L band)
13. TRAPUM (nearby galaxies)
14. TRAPUM (GCs)
15. TRAPUM (SNR, PWN, TeV)

MEERKAT

64 x 13.9 m dishes

$$\eta = 0.85$$

$$G = 2.8 \text{ K/Jy}$$

$$T_{\text{sys}} = 18 \text{ K}$$

$$\text{BW} = 856 \text{ MHz}$$



~8x Parkes in S/N

~64x Parkes in observing efficiency

MEERTIME

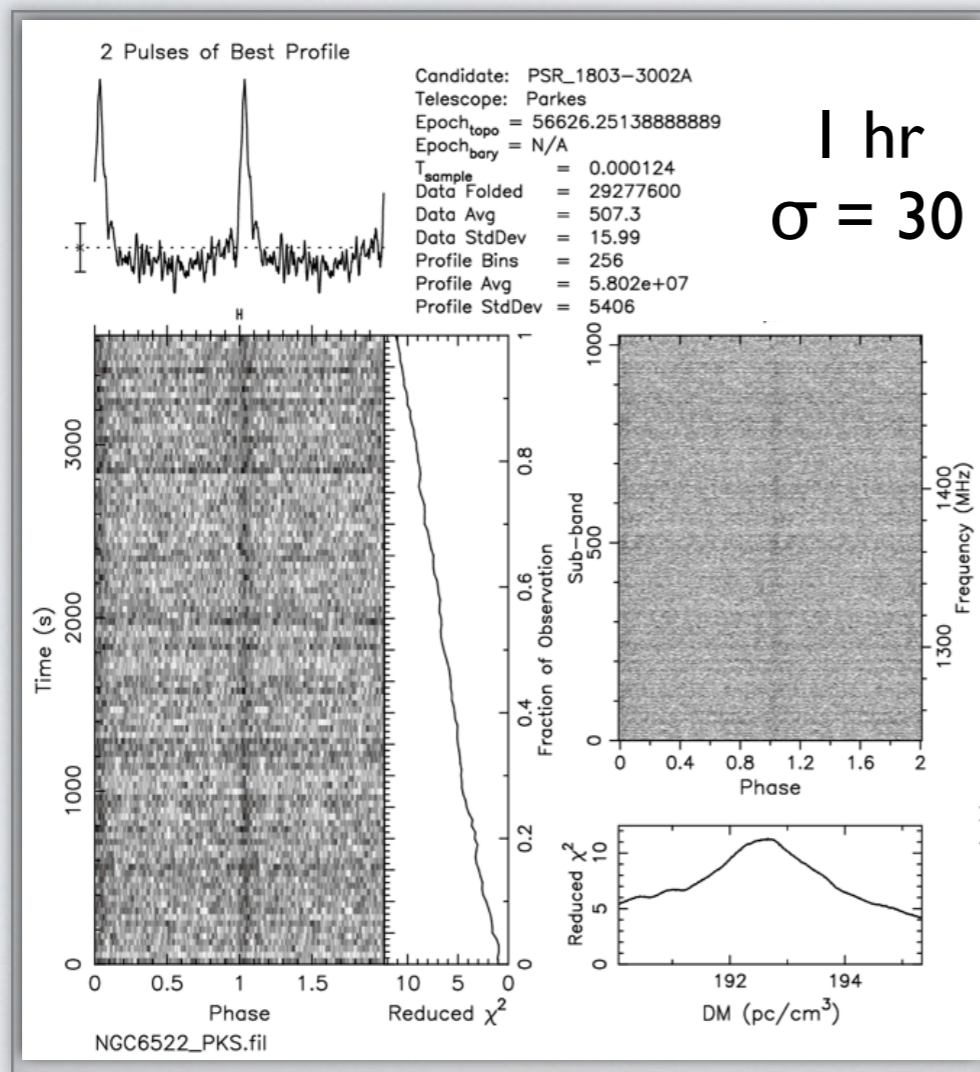
MeerKAT LSP on Pulsar Timing - P.I. Mathew Bailes

- Regular timing of ~ 1000 PSRs to
 - study relativistic gravity (GR, masses, EoS...)
 - search for GWs from SMBH binaries
 - study pulsar phenomenology (intermittency, moding, glitches, NS interiors, NS magnetospheres...)
 - study pulsars in GCs (ICM, ICB, binary evolution...)

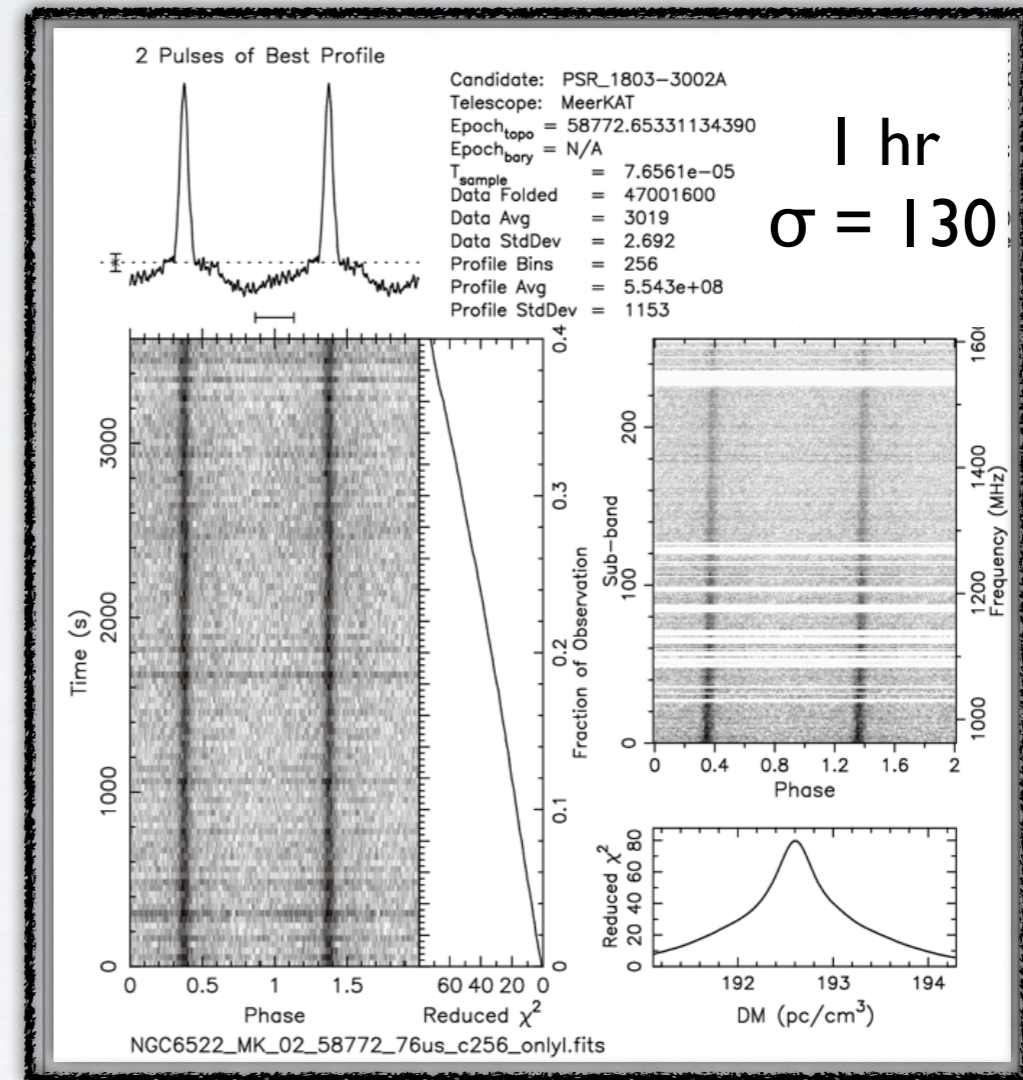
MEERTIME PERFORMANCES

NGC 6522A

Parkes (64 m) @L-band

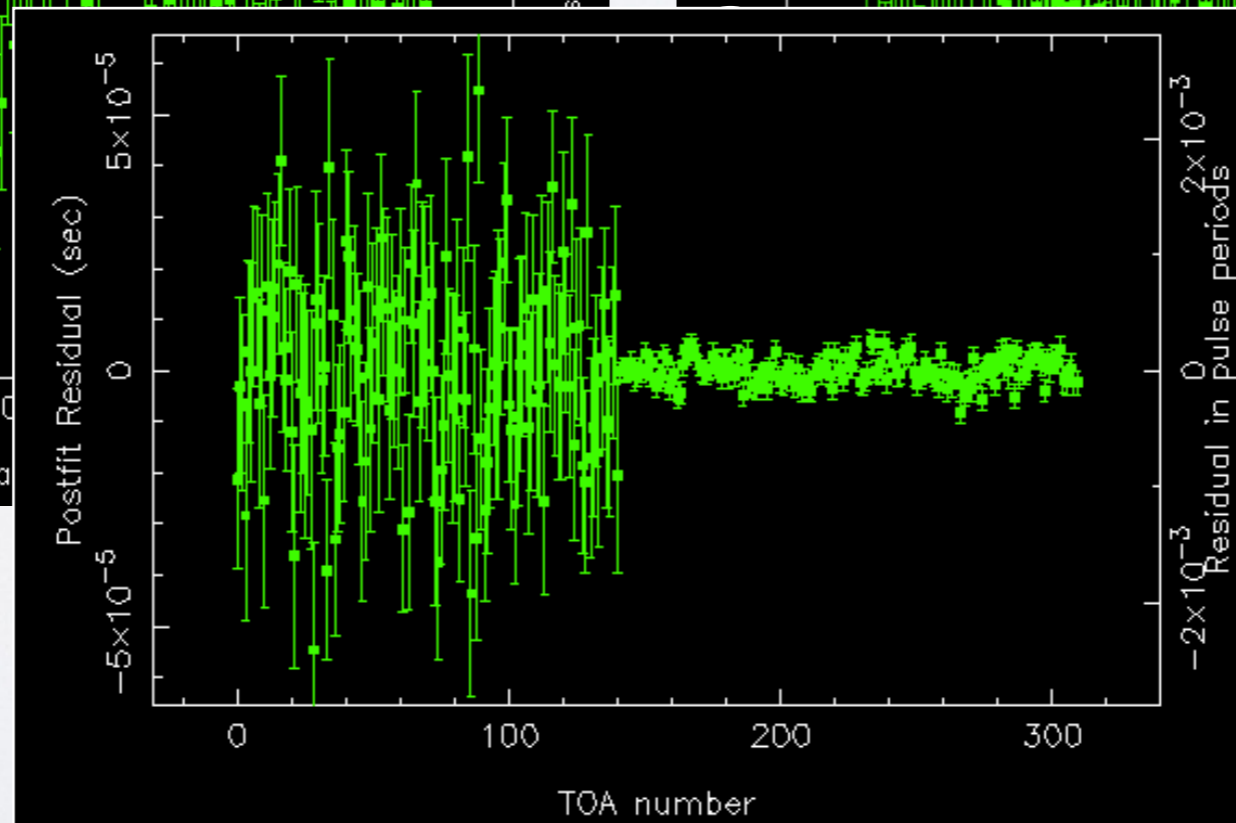
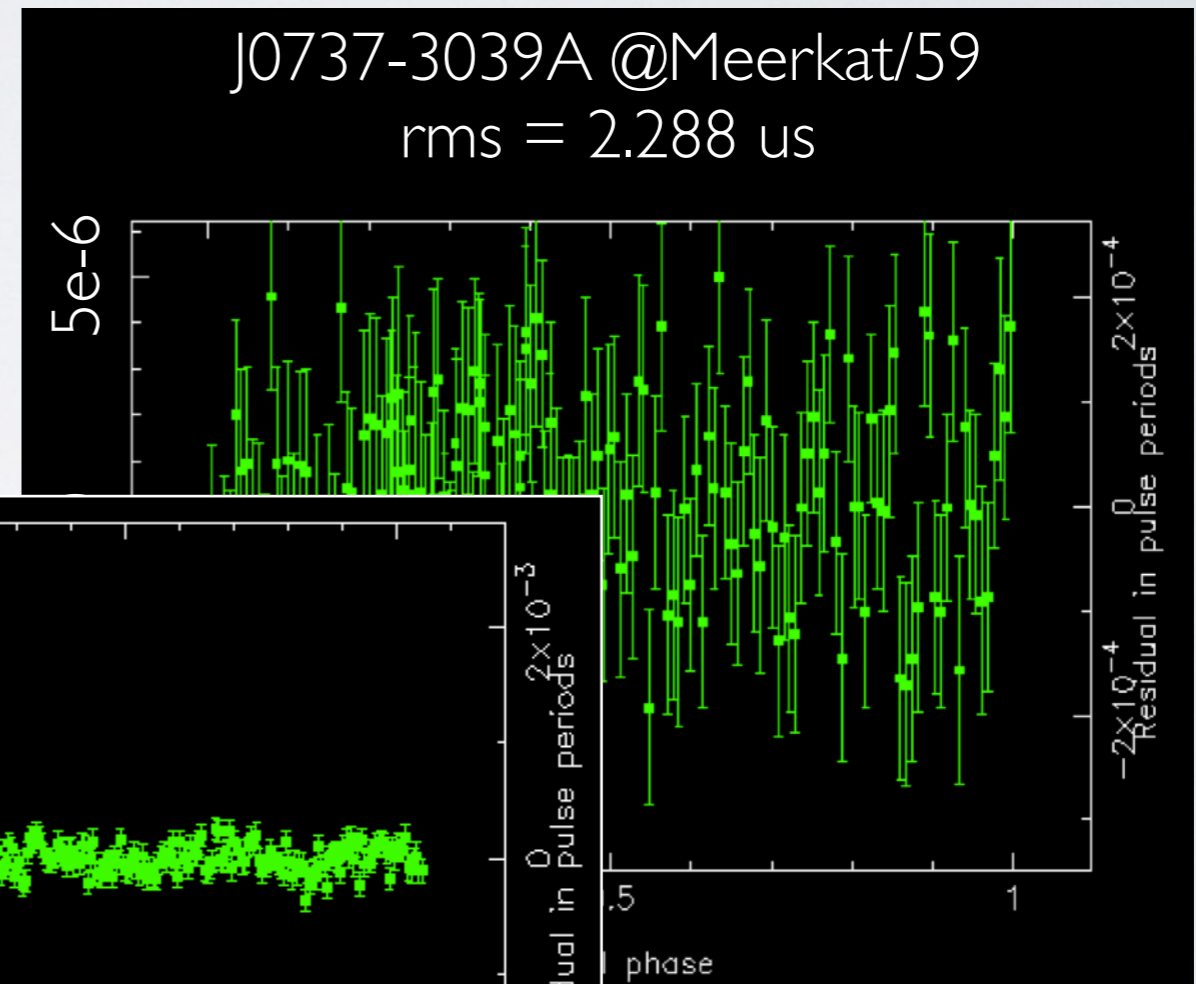
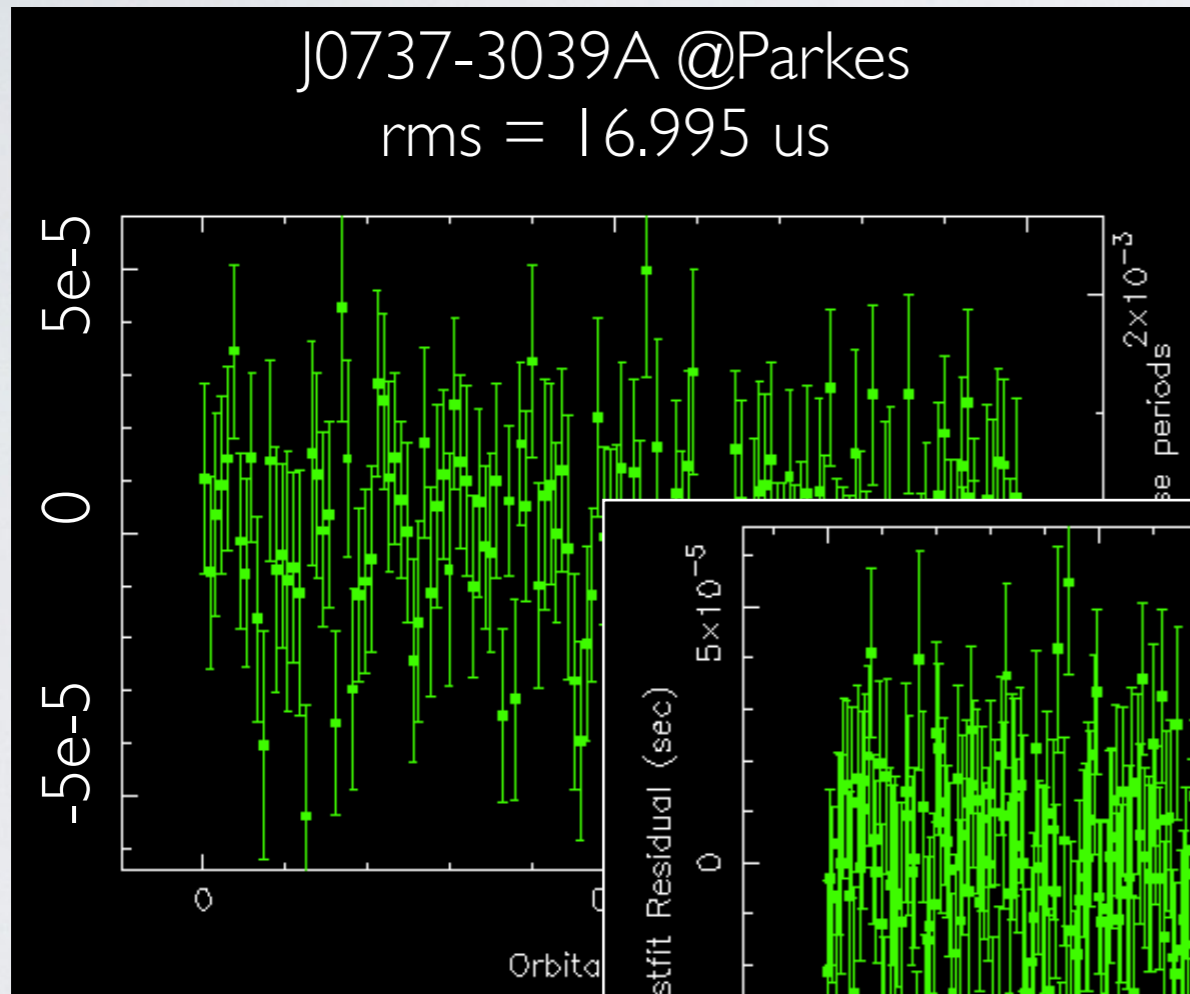


MeerKAT/40 antennas @L-band



Plots by A. Ridolfi

MEERTIME PERFORMANCES



MEERTIME FIRST RESULTS



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2. Johnston et al. (2020) **The Thousand-Pulsar-Array programme on MeerKAT I: Science objectives and first results**. *MNRAS*, 493, 6308. <https://arxiv.org/abs/2002.10250>, <https://ui.adsabs.harvard.edu/abs/2020MNRAS.493.3608J/abstract>
3. Bailes et al. (2020) **The MeerKAT Telescope as a Pulsar Facility: System verification and early science results from MeerTime**. *PASA* 37, 28B. <https://arxiv.org/abs/2005.14366>, ui.adsabs.harvard.edu/abs/2020PASA...37...28B/abstract
4. Abbate et al. (2020) **Giant Pulses from J1823-3021A observed with the MeerKAT telescope**. *MNRAS*, 498, 875. [2020MNRAS.498..875A/abstract](https://ui.adsabs.harvard.edu/abs/2020MNRAS.498..875A/abstract), ui.adsabs.harvard.edu/abs/2020MNRAS.498..875A/abstract
5. Serylak et al. (2020) **The Thousand-Pulsar-Array programme on MeerKAT IV: Polarisation properties of young, energetic pulsars**. Accepted by *MNRAS* Sept 11, 2020. astro-ph: <https://arxiv.org/abs/2009.05797>, Journal: <https://academic.oup.com/mnras/article/505/3/4483/6288428?guestAccessKey=1cd0124f-2dd1-4d36-82f3-644420e536e7>
6. Song et al. (2020) **The Thousand-Pulsar-Array programme on MeerKAT II: observing strategy for pulsar monitoring with subarrays**. Accepted by *MNRAS* Dec 4, 2020. <https://ui.adsabs.harvard.edu/abs/2020arXiv201203561S/abstract>
7. Parthasarathy et al. (2021) **Measurements of pulse jitter and single-pulse variability in millisecond pulsars using MeerKAT**. Accepted for publication by *MNRAS* Jan 5 2021. MN-20-3557-MJ.R3 arxiv.org/abs/2101.08531
8. Kramer et al. (2021) **"The Relativistic Binary Programme on MeerKAT: Science objectives and first results"**, MN-20-3133-MJ.R2, Accepted for publication by *MNRAS* Feb 5 2021. ui.adsabs.harvard.edu/abs/2021MNRAS.tmp..463K/abstract
9. Ridolfi et al. (2021) **"Eight new millisecond pulsars from the first MeerKAT globular cluster census"**, MN-20-5172-MJ.R1, Accepted for publication by *MNRAS* Mar 5, 2021. Preprint: arxiv.org/abs/2103.04800
10. Oswald et al. (2021) **"The Thousand-Pulsar-Array programme on MeerKAT - V. Scattering analysis of single-component pulsars"**, MN-20-4708-MJ.R2, Accepted for publication by *MNRAS* Apr 2, 2021. Preprint: arxiv.org/abs/2104.01081
11. Geyer et al. (2021) **"The Thousand-Pulsar-Array programme on MeerKAT III: Giant pulse characteristics of PSR-J0540-6919"**, MN-20-3097-MJ.R2, Accepted for publication by *MNRAS* May 14, 2021. [NASA ADS Link](#).

TRAPUM

TRansients and PUlsars with MeerKAT - P.I. Ben Stappers, M. Kramer

Search targets:

- High-energy point sources (Fermi)
- SNRs, PWN
- Globular Clusters
- Nearby Galaxies
- Galactic Plane

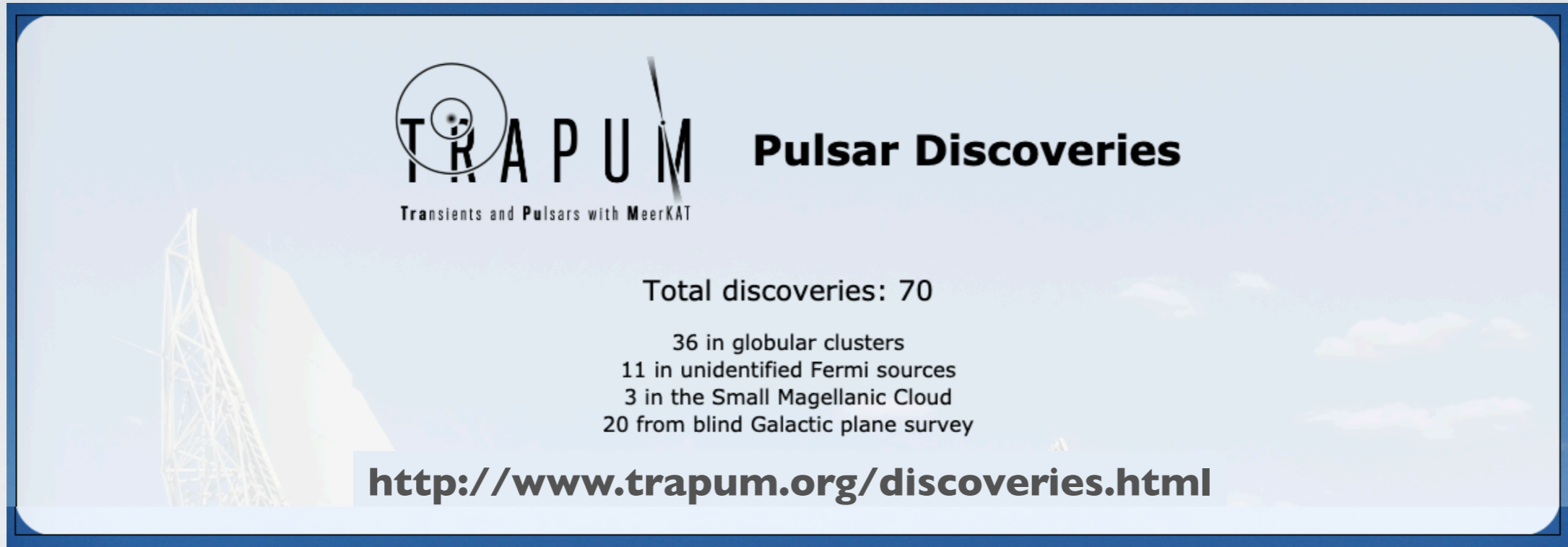
Search for pulsars and fast transients thanks to:

- exceptional sensitivity
- large FoV
- angular resolution through beam-forming

Search for transients:

- commensally, using extra resources (MeerTRAP).
- wide area searches using 64 dishes combined incoherently
- use up to 400 tied-array beams for localisation

TRAPUM FIRST RESULTS

A banner for TRAPUM Pulsar Discoveries. The background is a light blue sky with clouds and a faint image of the MeerKAT radio telescope structure on the left. The TRAPUM logo is at the top left, with the text 'Transients and Pulsars with MeerKAT' below it. To the right of the logo is the title 'Pulsar Discoveries'. Below the title is the text 'Total discoveries: 70' followed by a list of discovery types: '36 in globular clusters', '11 in unidentified Fermi sources', '3 in the Small Magellanic Cloud', and '20 from blind Galactic plane survey'. At the bottom right is the URL 'http://www.trapum.org/discoveries.html'.

- 52+ MSPs
- 33+ binaries (including at least one DNS)
- 6+ eclipsing
- MWL follow-up set up for the most interesting

INAF INVOLVEMENT

- A. Possenti
 - SKA Pulsar KSP group member
 - MeerTime INAF *representative*
 - MeerTime GC timing project *leader*
 - TRAPUM member
- M. Burgay
 - SKA Pulsar KSP group member
 - TRAPUM follow-up project *leader*
 - MeerTime member
- A. Ridolfi (TD)
 - SKA Pulsar KSP group member
 - TRAPUM GC search project *leader*
 - MeerTime member



+ many collaborators distributed over 7 INAF structures, to fully exploit the MeerKAT investigations across the e.m. spectrum
+ collaboration with Arcetri to develop new data analysis techniques

-
- 2 PRIN SKA-CTA projects funded
 - P.I. Possenti (OAC) - pulsars with MeerKAT
 - P.I. Giroletti (IRA) - transients, including FRBs

SUMMARY & CONCLUSIONS

- PSRs (and fast transients) studies will greatly advance thanks to the SKA and its precursors / pathfinders
- SKA precursors have PSRs (and FRBs) among their top priorities and the first results obtained with MeerKAT (MeerTIME / TRAPUM) are extremely promising
- INAF is deeply involved in PSR projects within the SKA framework
- INAF people involved in these projects have a proven expertise and many international collaborations in all major PSR science and sw development topics that the SKA will keep on investigating

We are ready for the SKA challenges!

THANK YOU!