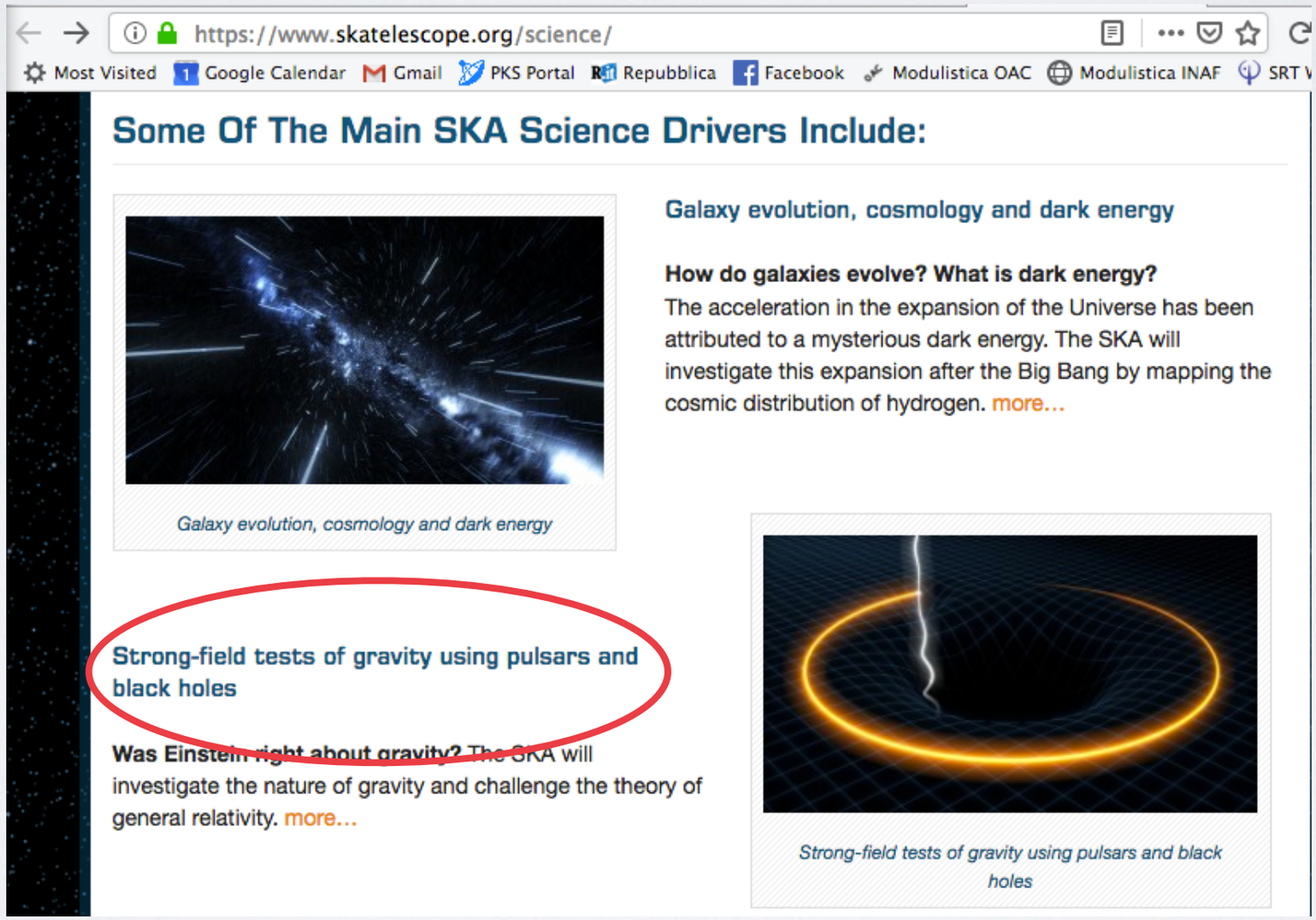
PULSARS WITH MEERKAT

INAF involvement towards the SKA

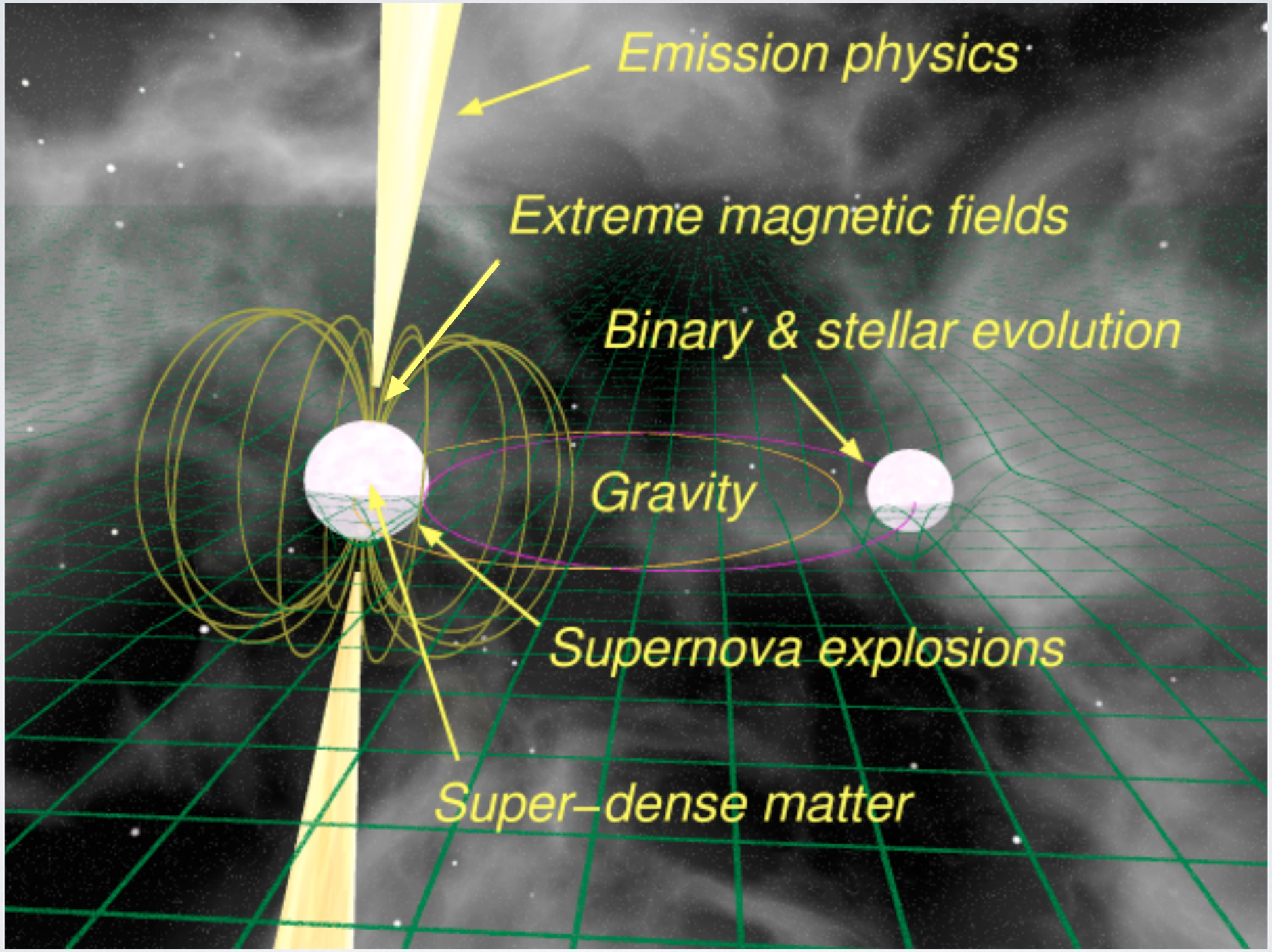
Marta Burgay - INAF Osservatorio Astronomico di Cagliari

PULSARS IN THE SKA CONTEXT

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

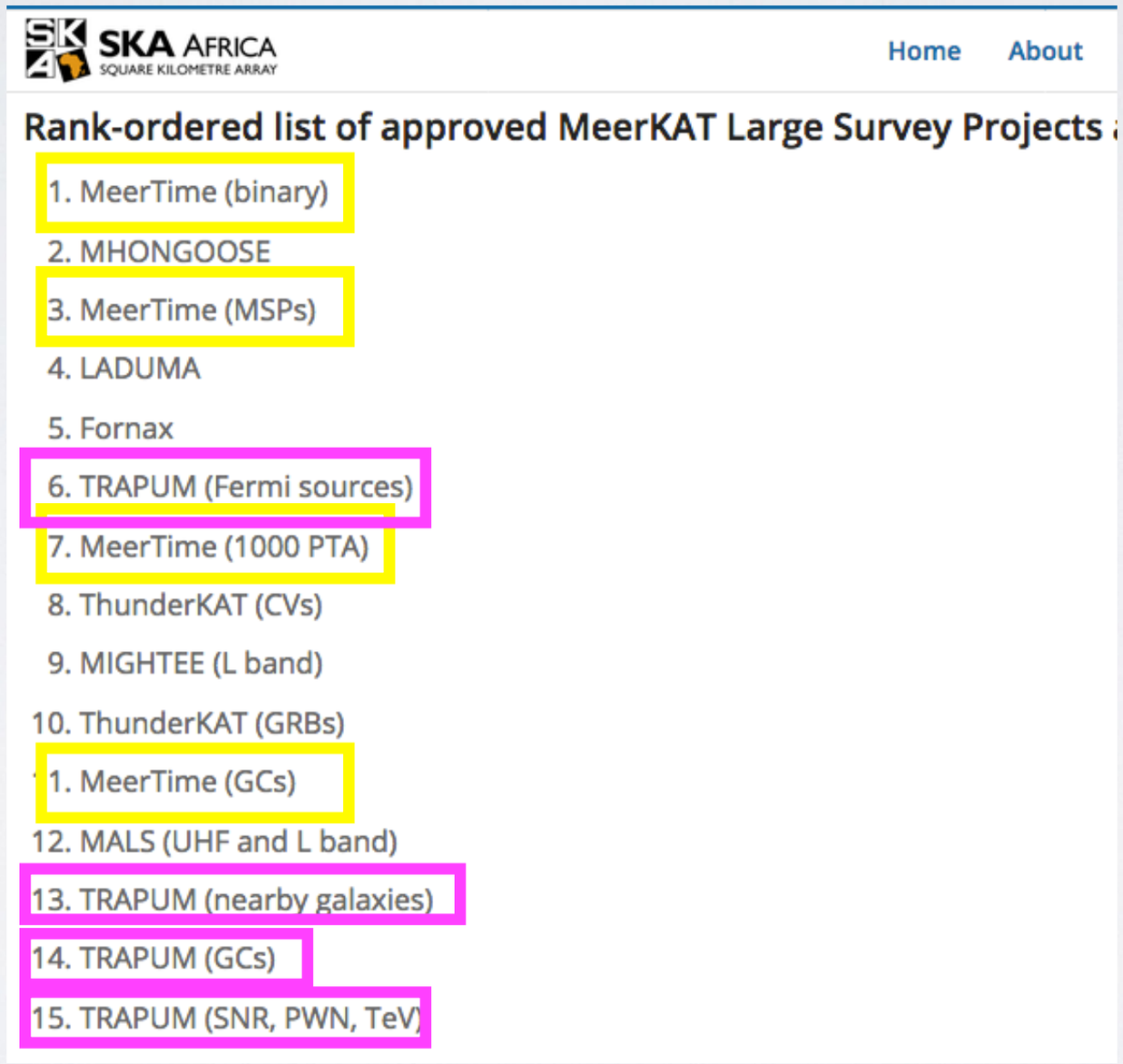


The scientific impact of Pulsars



Stappers 2015

PULSARS WITH THE MEERKAT



MeerKAT

64 x 13.9 m dishes
$\eta = 0.85$
G = 2.8 K/Jy
Tsys = 18 K
BW = 856 MHz

~8x Parkes in S/N
~64x Parkes in observing efficiency

MeerTime

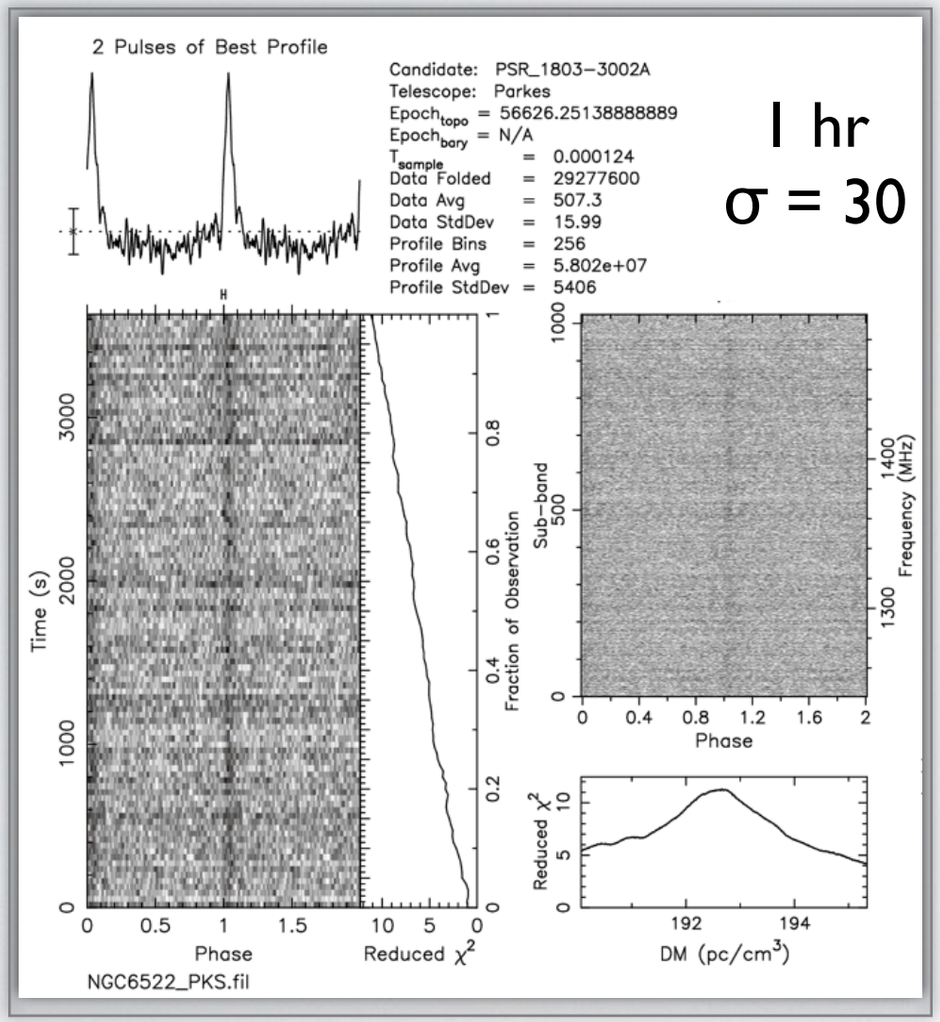
MeerKAT LSP on Pulsar Timing - P.I. Mathew Bailes

- 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…)

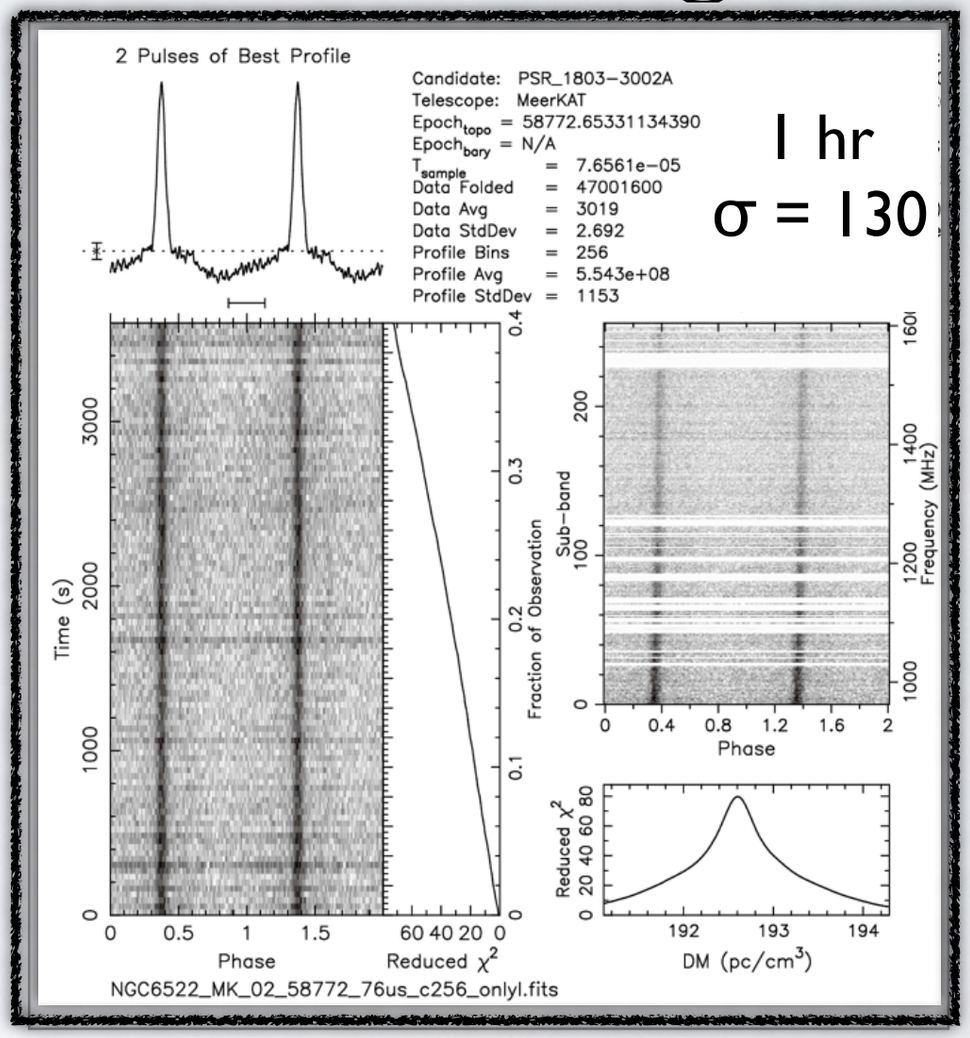
MeerTime Performances

NGC 6522A

Parkes (64 m) @L-band

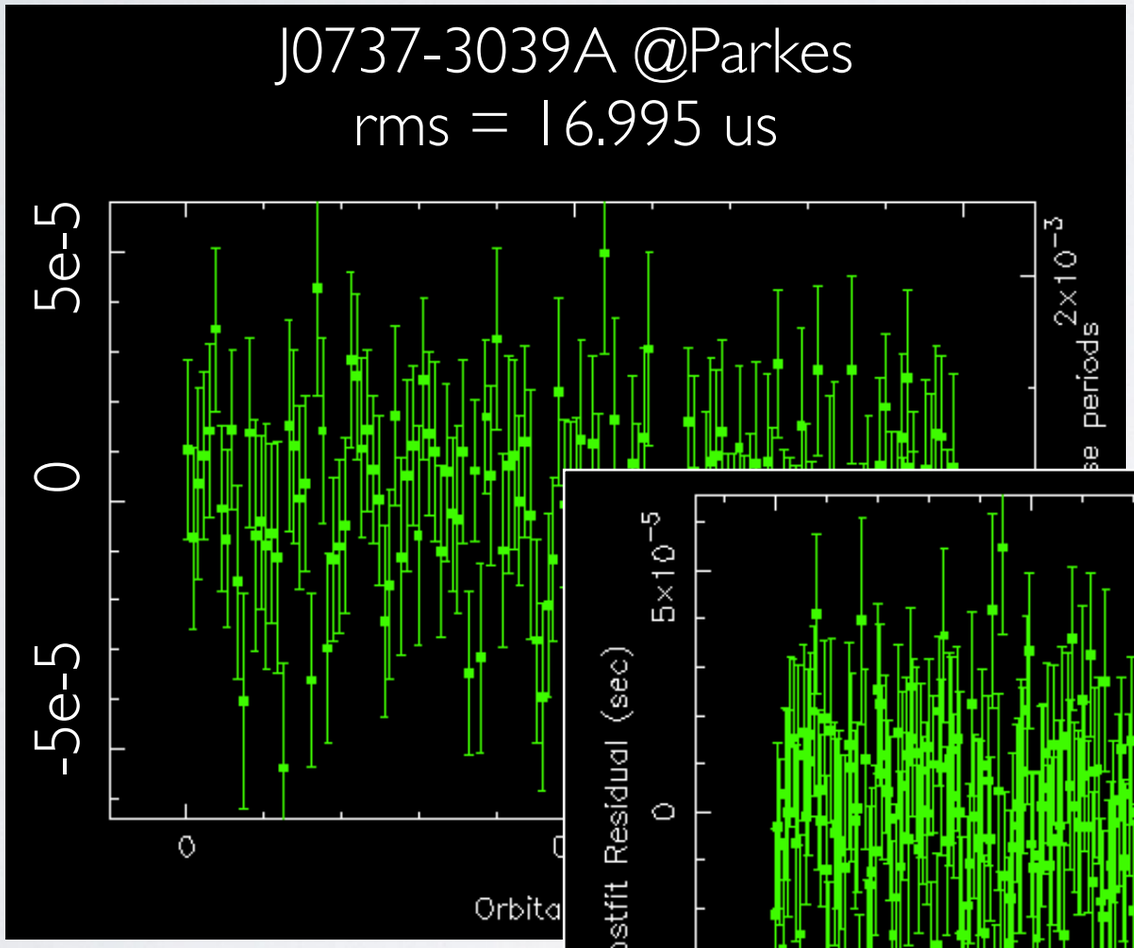


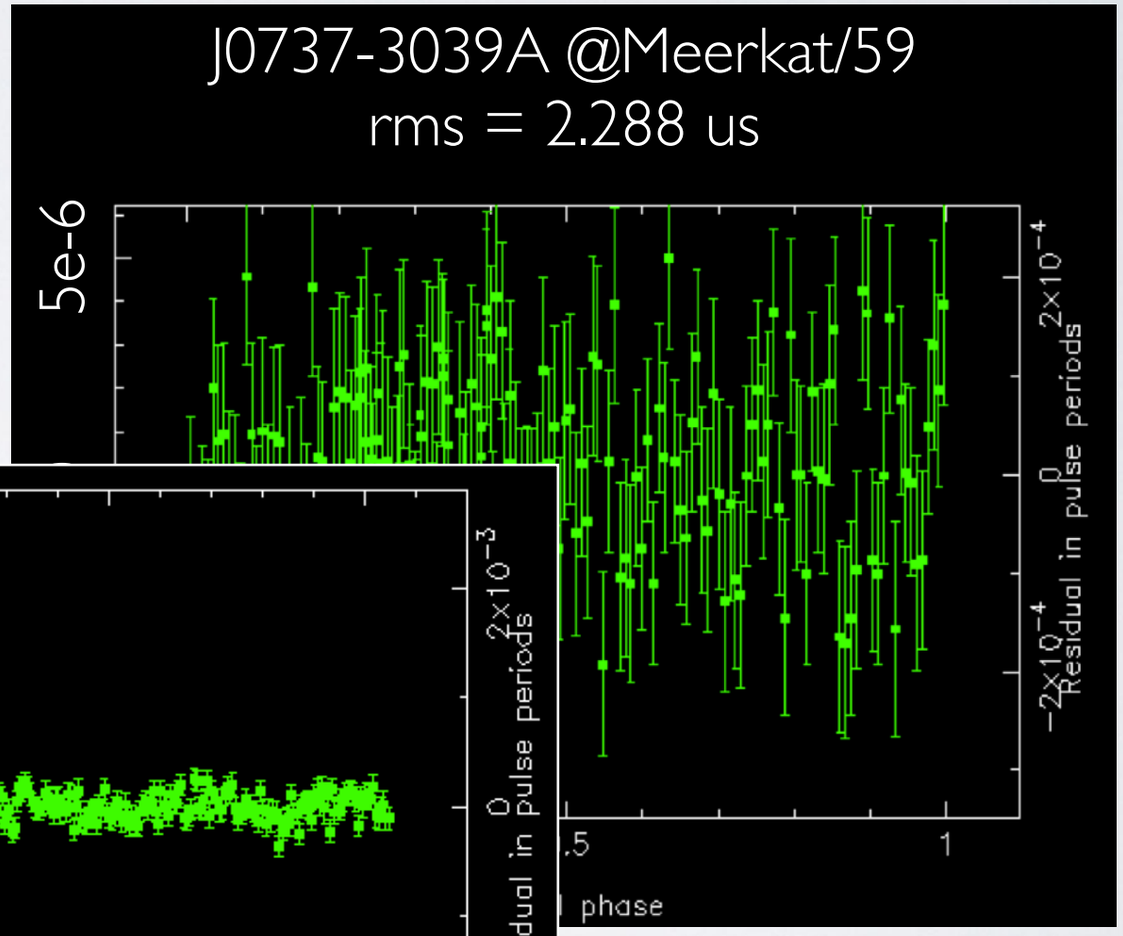
MeerKAT/40 antennas @L-band

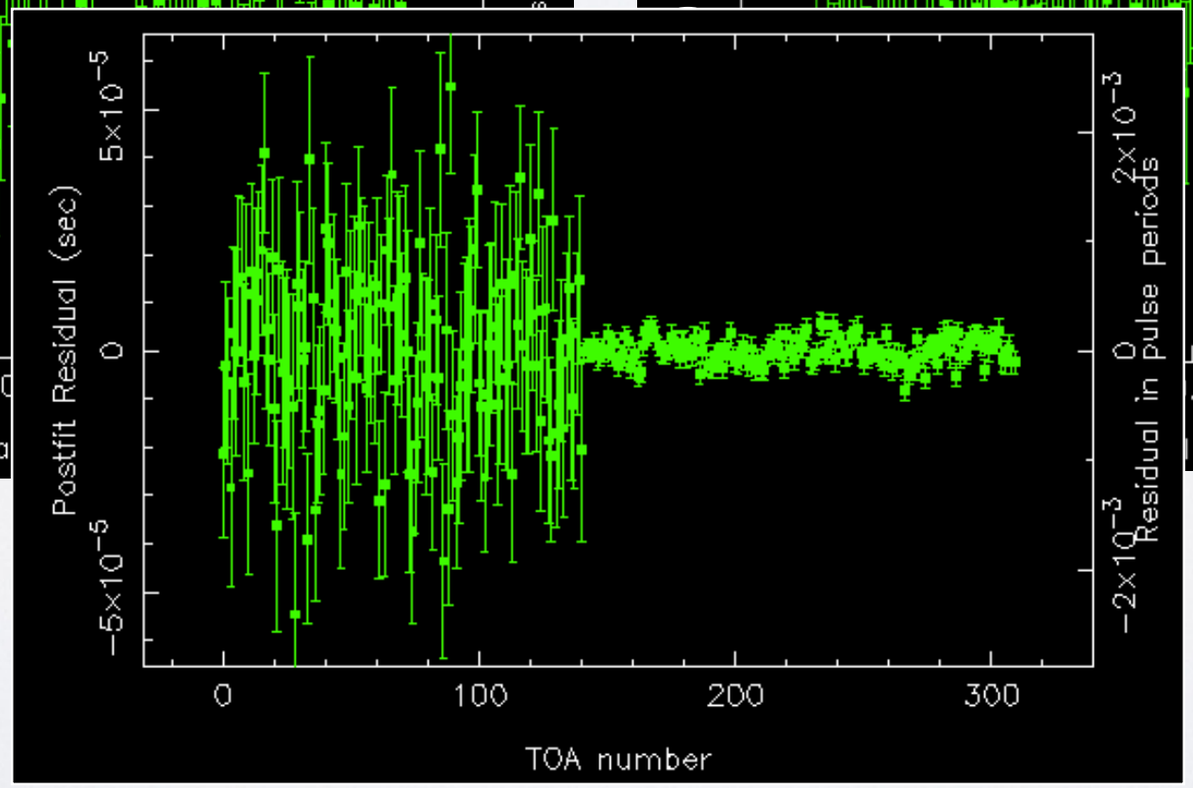


Plots by A. Ridolfi

MeerTime Performances







MeerTime First Results

MEERTIME About Science Themes Team News! Data Publications Policies Contact Intranet

1. Bailes et al. (2016) ***MeerTime - the MeerKAT Key Science Program on Pulsar Timing.*** Proceedings of MeerKAT Science: On the Pathway to the SKA. 25-27 May, 2016 Stellenbosch, South Africa (MeerKAT2016). **pos.sissa.it/277/011/pdf** **adsabs.harvard.edu/abs/2016mks..confE..11B**
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**, **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

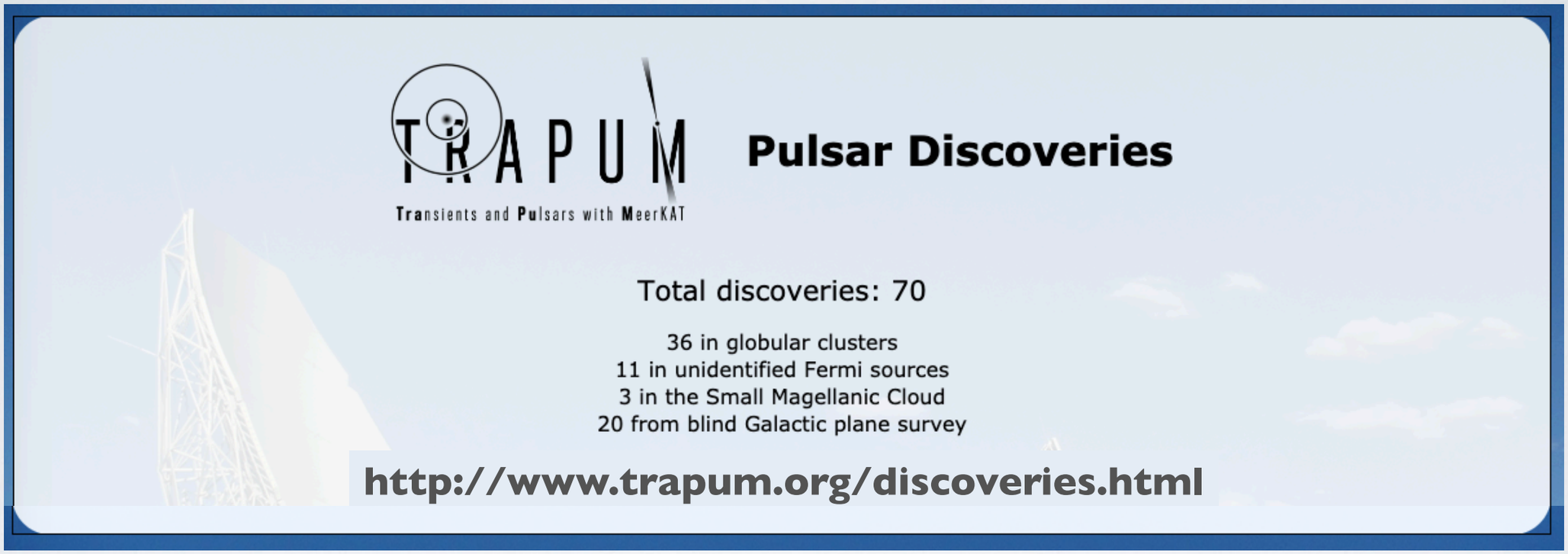
Search for pulsars and fast transients thanks to:

- 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



- 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

OAC Osservatorio Astronomico di Cagliari

+ 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

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- 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!