Localising Fast Radio Bursts with MeerKAT

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Introduction

While there are more fast radio bursts (FRBs) being discovered all the time, only one FRB has been definitively localised, FRB 121102 or "the repeater" [1]. The non-repeating nature of FRBs (except FRB 121102) and the lack of spatial information from usual detection methods makes localisation challenging. A lot of information was discovered about FRB 121102 just by localising it [2], which means that localising FRBs, repeating or not, is essential to finding out more about FRB environments and progenitors.

MeerKAT

The (more) Karoo Array Telescope is an interferometer located in South Africa that has:

- 64 x 13.5 m diameter dishes
- Three bands:
  - S-band (1.6-3.5 GHz)
  - L-band (900-1420 MHz)
  - UHF (580-1000 MHz)
- 1.7 deg^2 field of view at 1 GHz (Fig. 2)
- 64 μs timing resolution
- 0.06 Jy sensitivity (10σ detection, 1 ms width, 750 MHz bandwidth, 64 dishes)

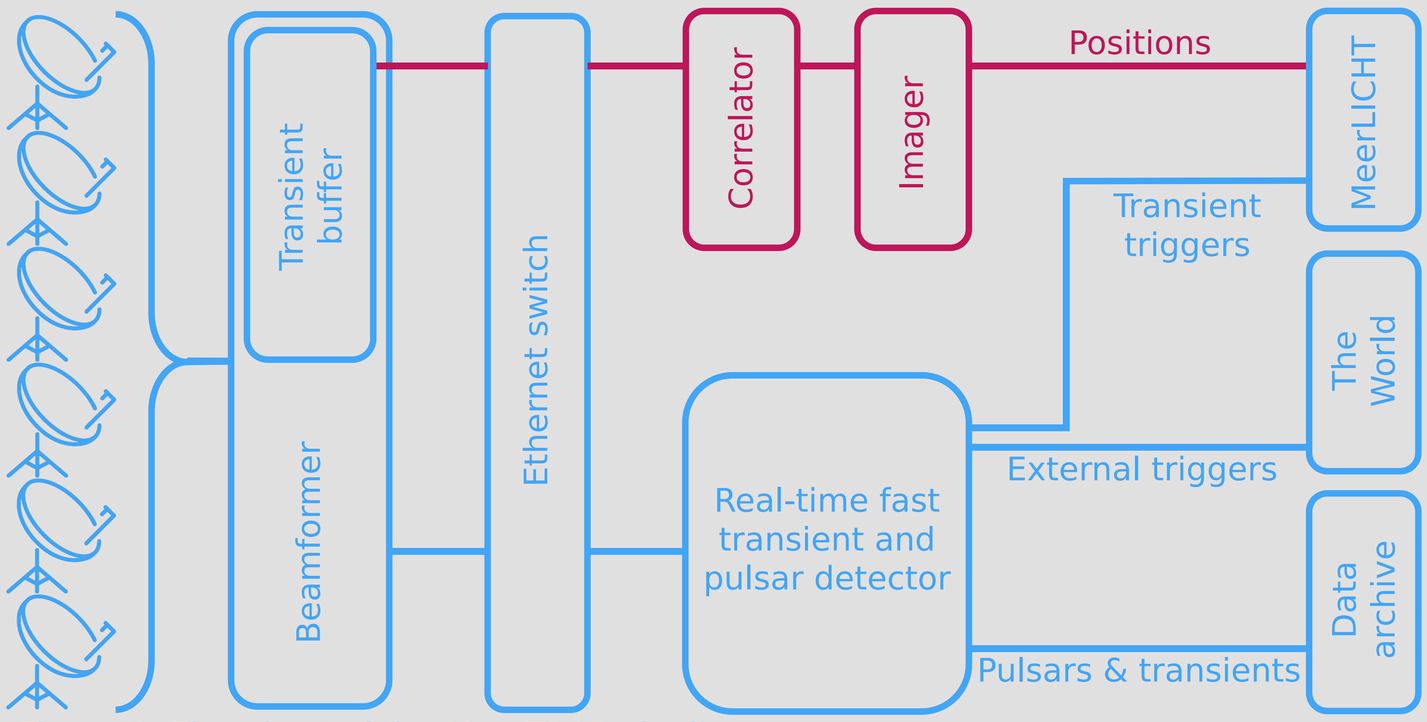

Figure 1: Flowchart of the MeerTRAP pipeline

MeerLICHT

MeerKAT is the first radio telescope to have an optical telescope, MeerLICHT, simultaneously observing the same field of view every night. MeerLICHT has a 0.65 m mirror with a 2.7 deg^2 field of view (Fig. 3) and can detect up to a magnitude of 22.2 in a 1 min integration. If an FRB is detected using MeerTRAP, then the MeerLICHT images can be searched for a persistent optical source, or possibly an optical burst.

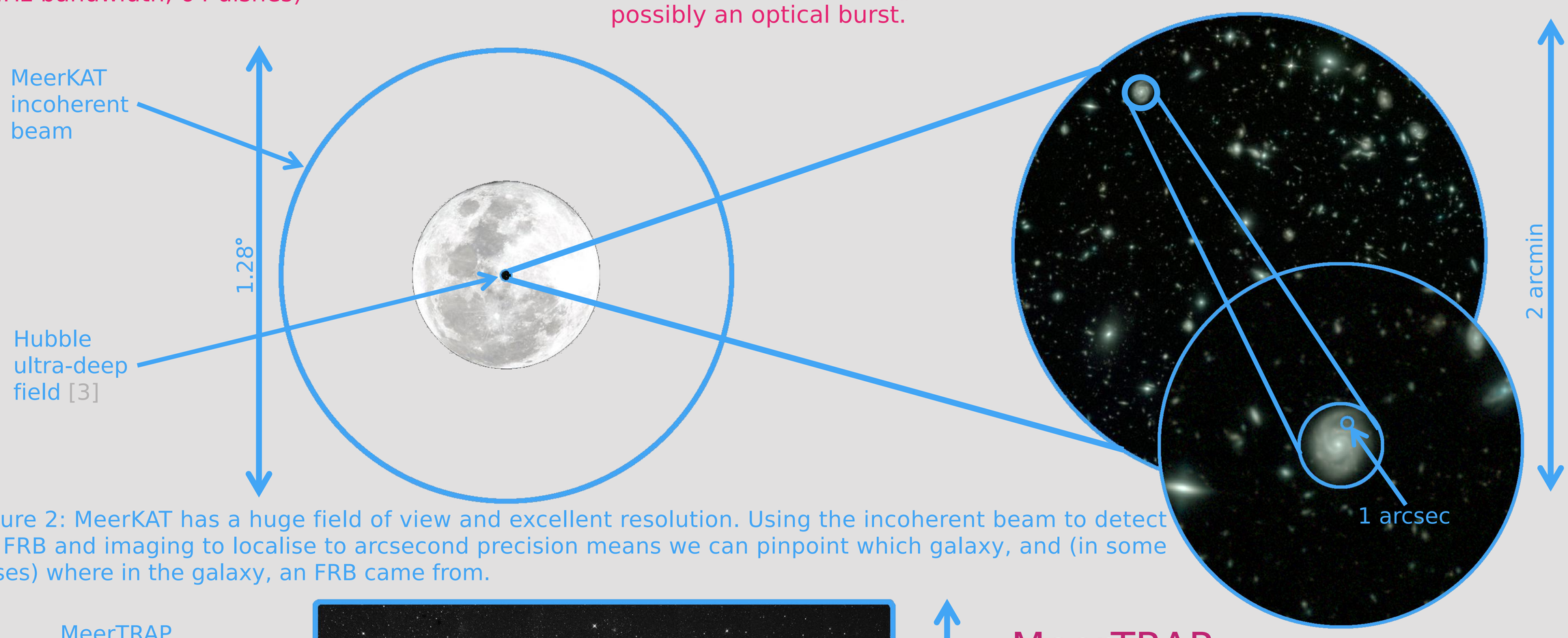

Figure 2: MeerKAT has a huge field of view and excellent resolution. Using the incoherent beam to detect an FRB and imaging to localise to arcsecond precision means we can pinpoint which galaxy, and (in some cases) where in the galaxy, an FRB came from.

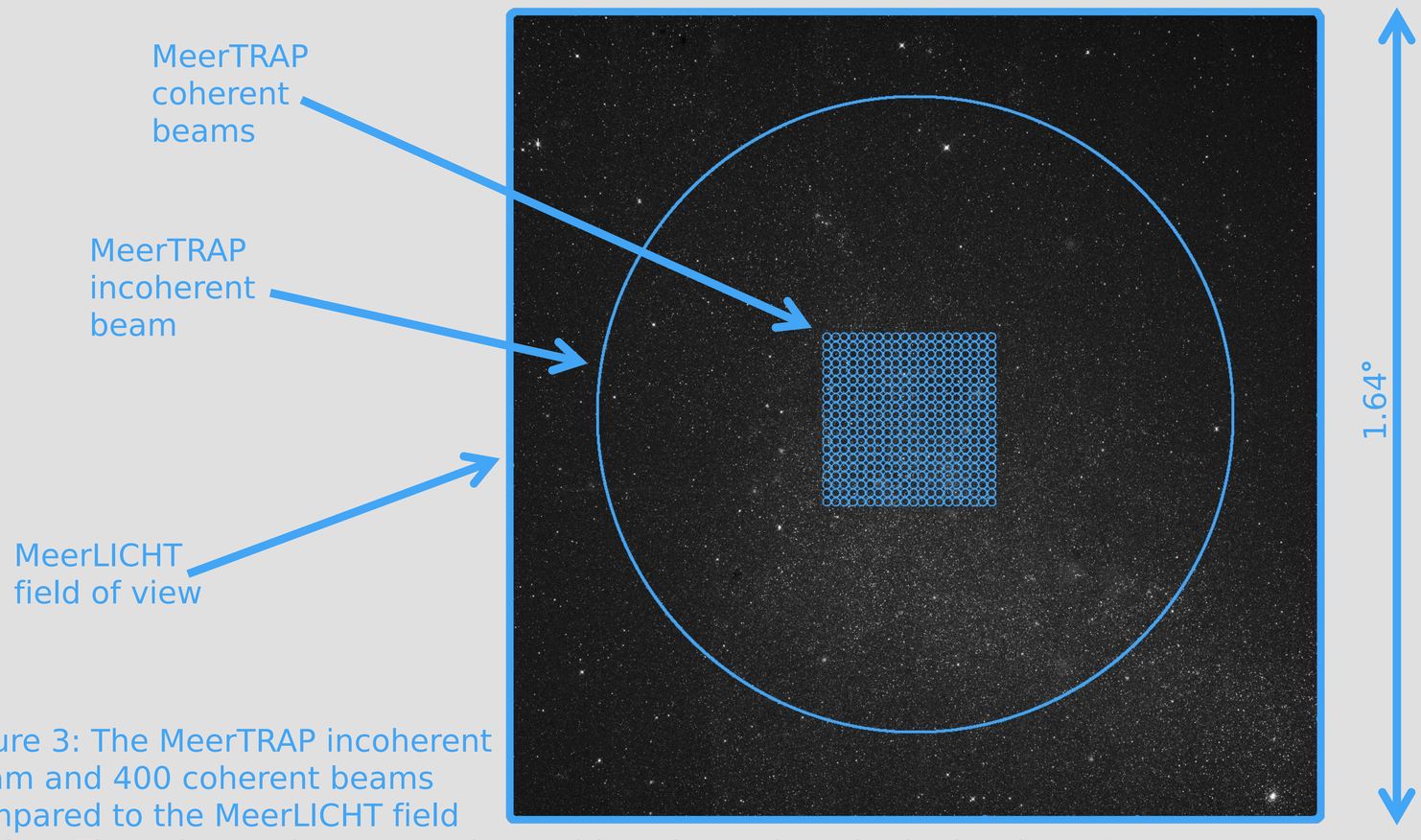

Figure 3: The MeerTRAP incoherent beam and 400 coherent beams compared to the MeerLICHT field of view. The coherent beams can be positioned anywhere in the incoherent beam and do not need to be in a tight grid. The background image is a MeerLICHT image of the Small Magellanic Cloud (courtesy of the MeerLICHT group).

MeerTRAP

MeerTRAP (more TRAnsients and Pulsars) is a project using commensal MeerKAT time to search for pulsars and transients. MeerTRAP will use the 1.7 deg^2 MeerKAT incoherent beam and 400 ~0.1deg^2 coherent beams (Fig. 3) to search for fast radio transients in real time. A schematic of the MeerTRAP pipleine is shown in Fig. 1.

Localising FRBs with MeerTRAP

Once an FRB has been detected in real time in the transient buffer, the spatial information will be saved. We will then correlate and image the data to locate the FRB up to arcsecond precision (Fig. 2). Localising the source means we can search the MeerLICHT observations for persistent sources or bursts, then follow-up observations can be performed to investigate the environment of FRB progenitors.

MeerTRAP: B. Stappers, S. Sanidas, M. Caleb, K. Rajwade, F. Jankowski, V. Morello, L Driessen

[1] Chatterjee et al. 2017, Nature, 541, 58 [2] Tendulkar et al. 2017, Astrophysical Journal Letters, 834, L7 [3] udf12.arizona.edu

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