

Transients with Parkes

What it's good at, and how to make it better

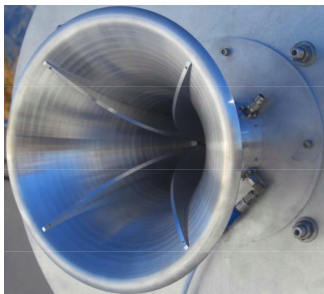
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Contents

- Targeted searches
- Blind searches
 - Slow transients
 - Fast transients
 - Really fast transients
- Technical considerations

Assumed receivers



single-pixel feed

- from suggestion by Dick Manchester
- 0.7–4.0 GHz
- $T_{\text{sys}} \sim 25 \text{ K}$



Phased-Array Feed (PAF)

- developed for ASKAP
- 0.7–1.8 GHz
- $T_{\text{sys}} \sim 50 \text{ K}$

Transients are typically less intense at higher frequencies.

Targeted searches

Use cases:

- Monitoring likely/known transients
- Follow-up on non-radio transients

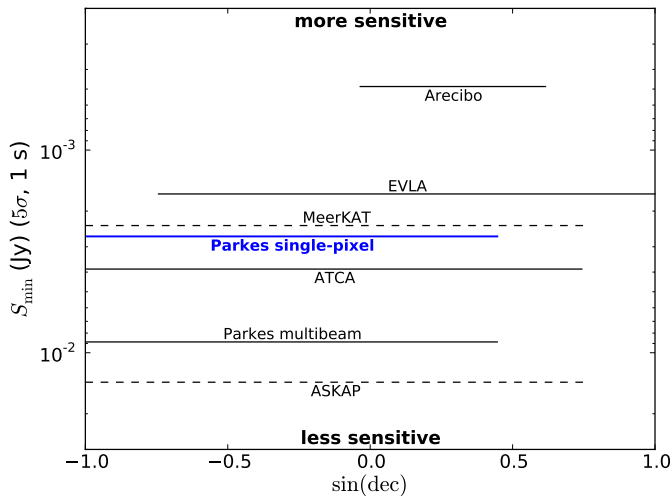
Science:

- stellar transients (brown dwarfs, flare stars)
- AGN outbursts
- X-ray binaries
- intraday variability
- maser flares
- GRB follow-up

Only point-source sensitivity matters:

$$S_{\min} = N_{\sigma} \frac{1}{\sqrt{t_{\text{obs}} \Delta \nu}} \frac{2kT_{\text{sys}}}{A_{\text{eff}}}$$

Compared to other instruments



Blind searches: Slow transients

Transients slower than telescope dwell time, $O(5 \text{ secs})$

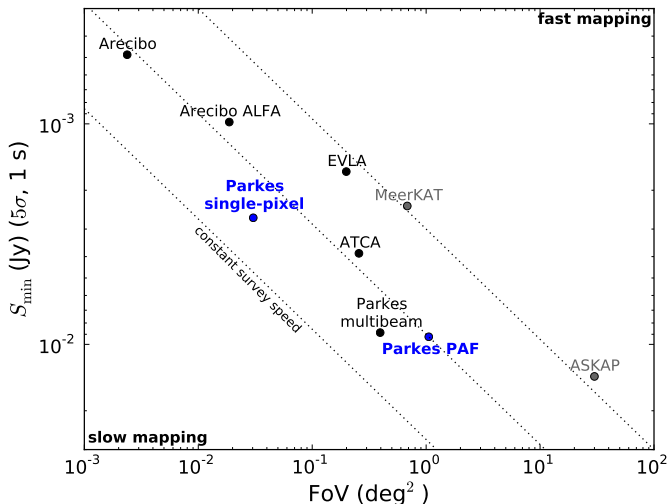
Science: blind searches for

- stellar transients
- AGN outbursts
- orphan GRB afterglows

Figure of merit is survey speed:

$$\text{FoV}/S_{\min}^2$$

Compared to other instruments



Blind searches: Fast transients

Science:

- RRATs
- radio supernovae
- Lorimer bursts
- atmospheric transients (perlytons?)

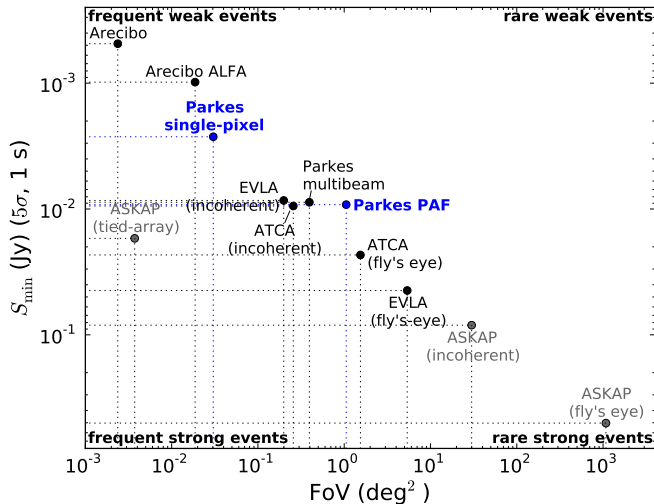
Cannot use standard interferometric imaging with arrays. Options:

- form tied-array beams
- sum antennas incoherently
- fly's-eye pointing
- others being explored (Bannister & Cornwell 2011)

No clear figure of merit (see Macquart 2011).

Search sensitivity-FoV phase space.

Compared to other instruments



Blind searches: Really fast transients

Pulses with inherent width $O(\text{nanosecs})$; smaller than array sizes.

Science:

- cosmic ray air showers
- lunar particle cascades
- nano-giant pulses

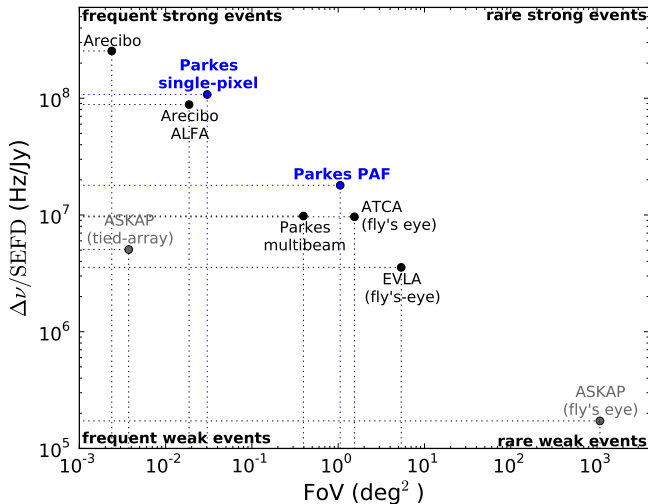
Cannot use arrays together, except with tied-array beams.

Signal scales with $\Delta\nu$ instead of $\sqrt{\Delta\nu}$ (coherent across band).

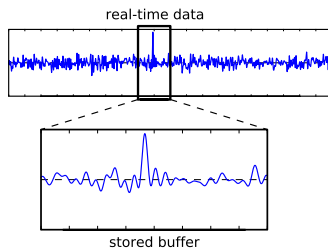
Figure of merit:

$$\Delta\nu/\text{SEFD (and FoV)}$$

Compared to other instruments



Triggering



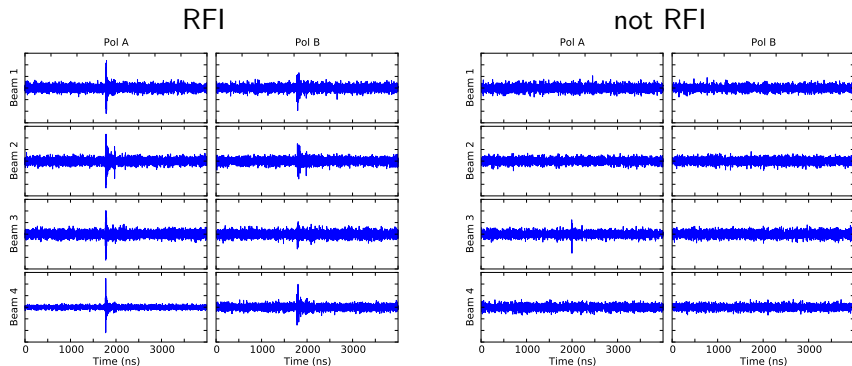
As time resolution increases, so does data rate.

Cannot store all data.

- Need triggered detection.
- Need real-time processing.

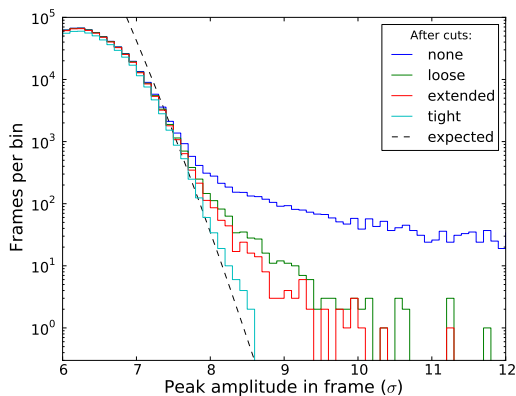
Different from pulsar searches.

Anticoincidence



One-off fast transients look much like RFI.
But: they appear in multiple beams.

Anticoincidence



$\sim 1,000,000 : 0$ RFI rejection is possible.

But not with a single-pixel feed.

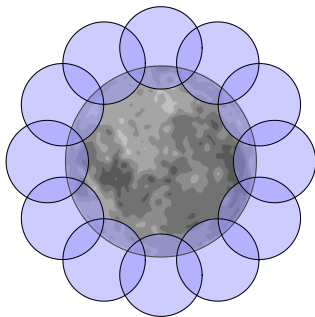
Omnidirectional feed external to dish, for RFI identification?

Conflicting technical requirements

ASKAP PAFs may be interlaced/dithered to achieve flat field.
Great for imaging; not so great for transients.

ASKAP PAF bands: 700–1200, 850–1440 and 1400–1800 MHz.
On Parkes: separate beamformers?
Makes transients difficult.

Non-standard PAF beams



Some experiments have different pointing requirements.

Lorimer bursts: reconstruction improved if beam is on target.

Buffer individual PAF elements?

Backend options

For slow transients, backend requirements are as for continuum mapping.

For fast transients, options:

- Adaptable backend capable of implementing required processing for any conceivable experiment.
- No fast transients capability. Replace with the above in five years' time, when computing power is cheaper.
- Provide capacity for external groups to bring their own backends for particular experiments. (Where in the signal path?)

Harder for a PAF than for a single-pixel feed.

Conclusions

- With new receivers, Parkes can explore new regions of transient phase space.
- For slow transients, arrays win. Parkes is better at fast transients.
- Signal-processing becomes harder as you go to shorter timescales.