Resolving spatial and temporal shock structures using LOFAR observations of type II radio bursts

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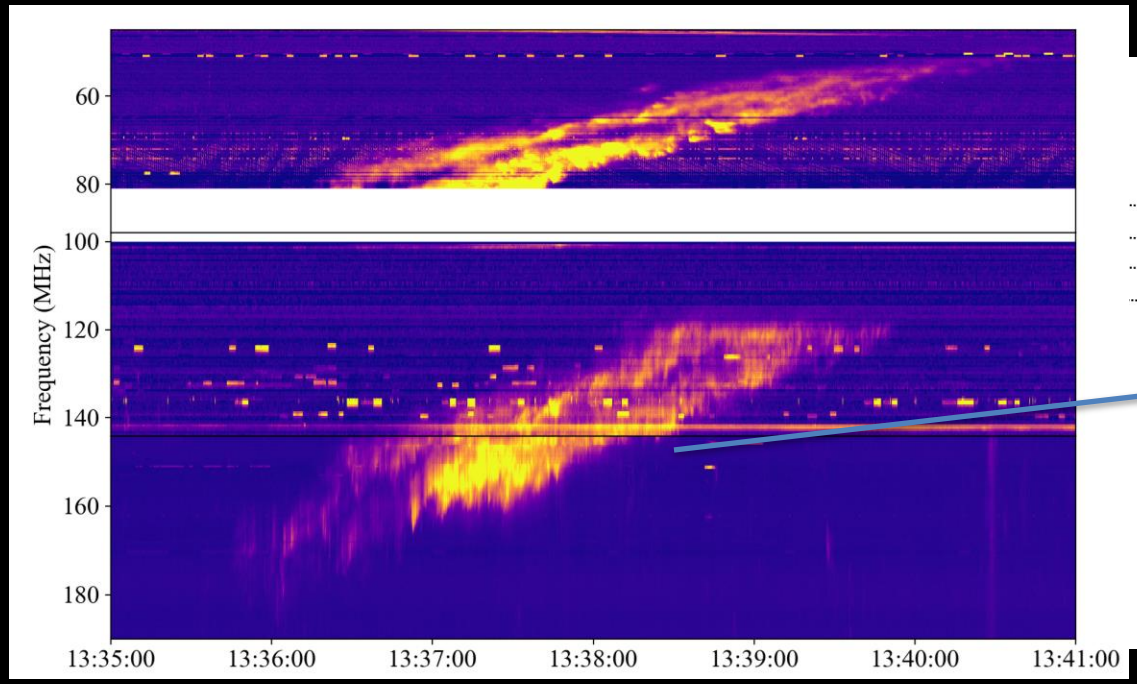
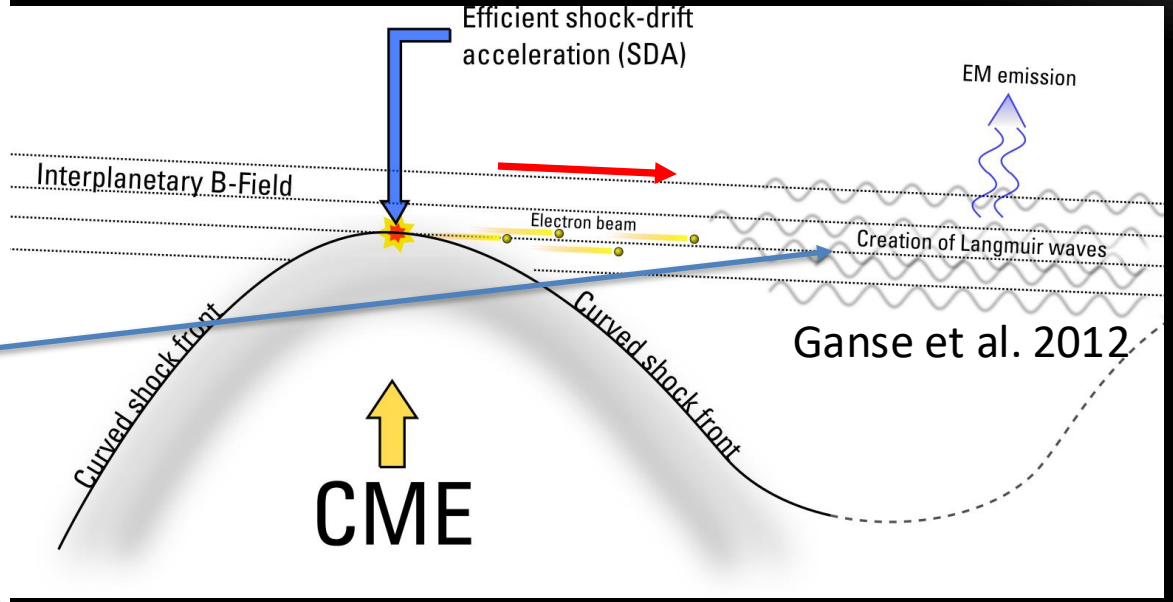
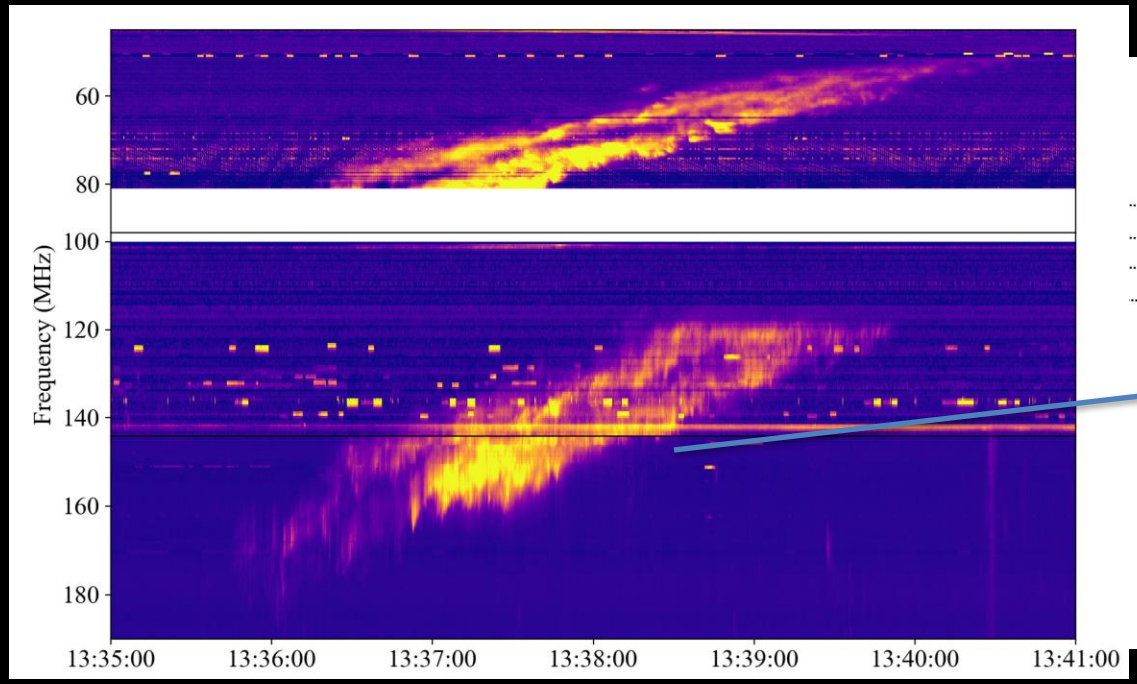
Type II Radio Bursts

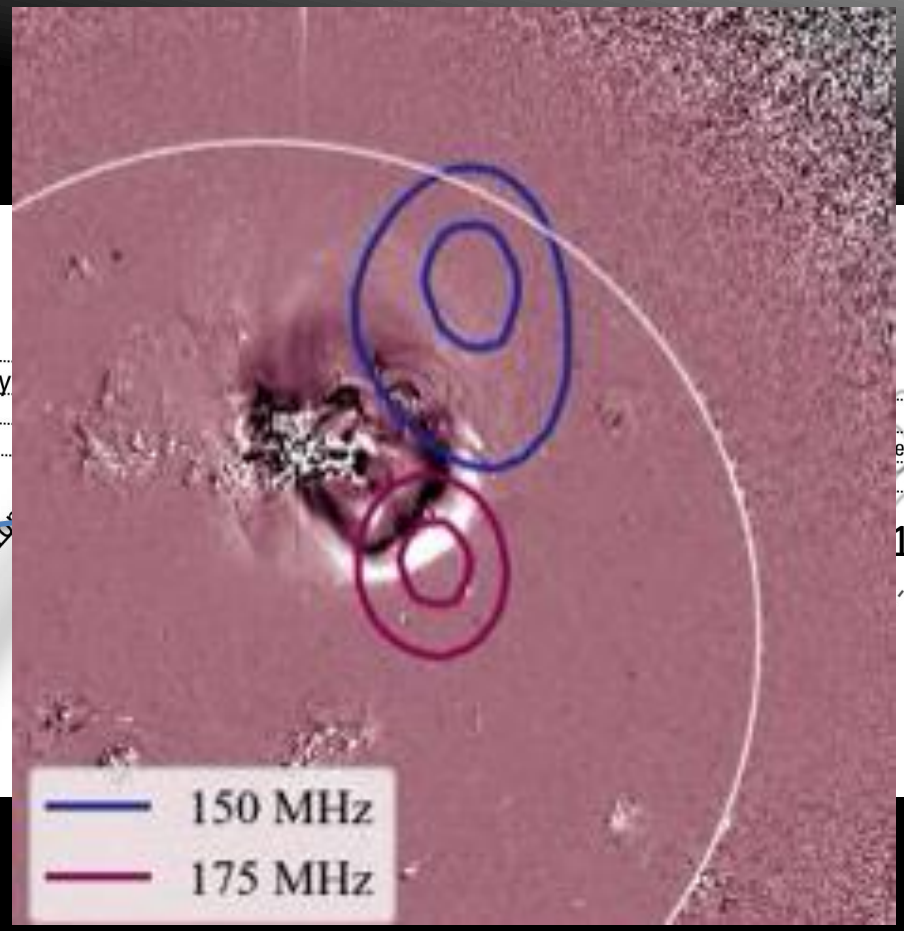




Type II radio bursts are the radio signature of shock-accelerated electrons in the corona.

Type II Radio Bursts





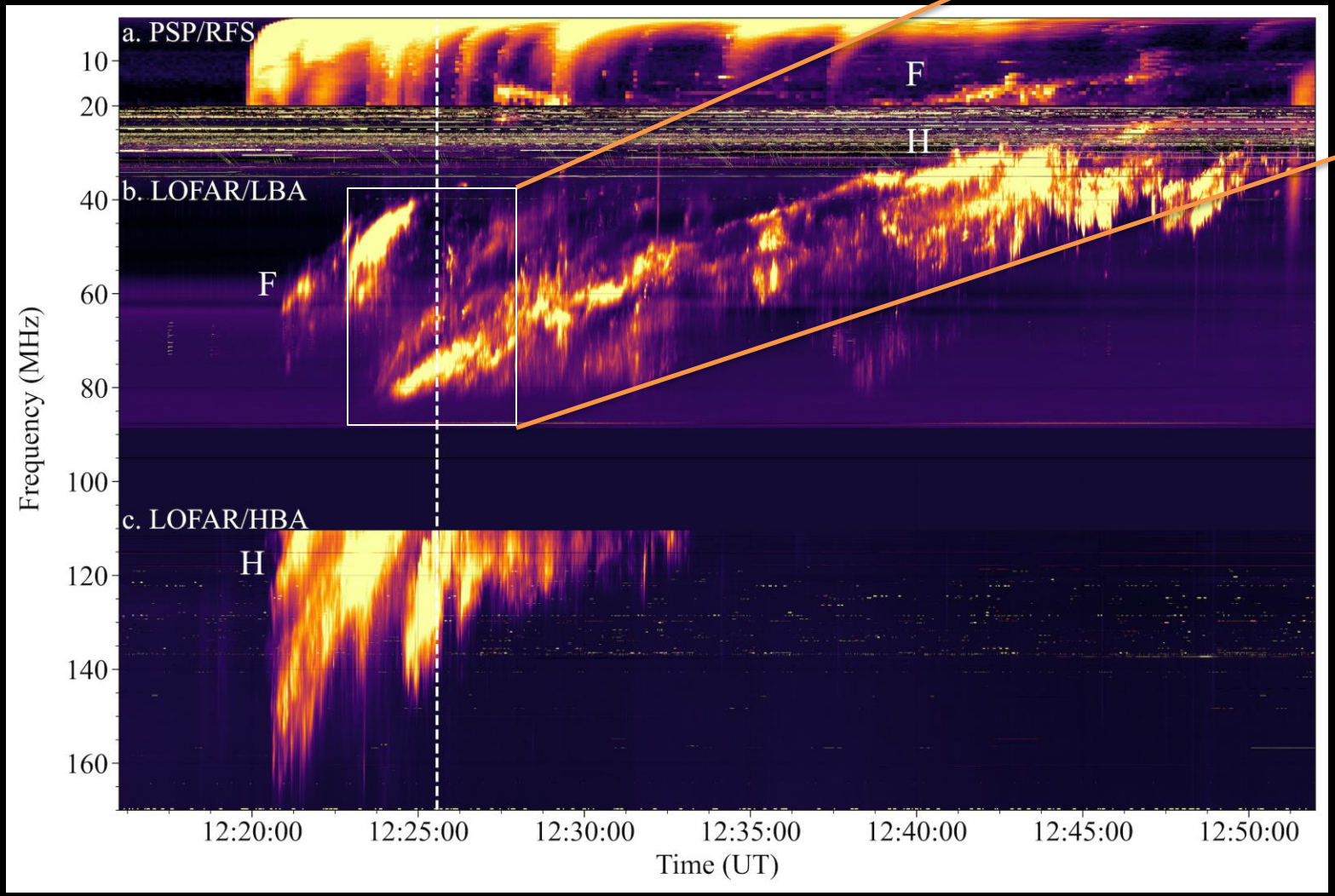
Type II radio bursts are the radio signature of shock-accelerated electrons in the corona.

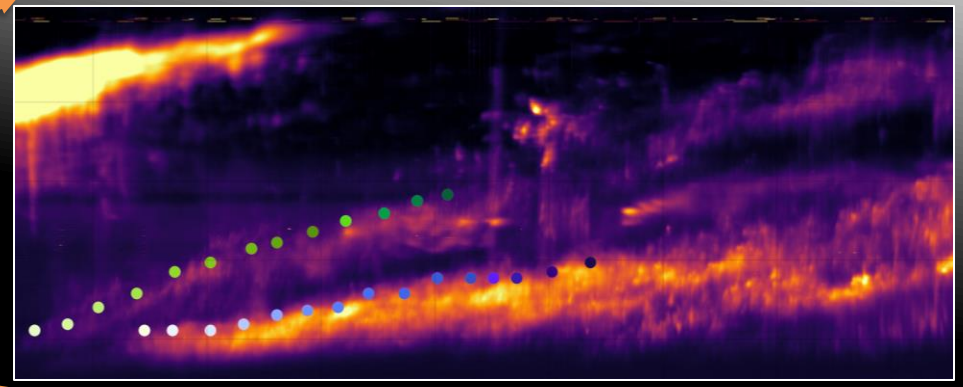
LOFAR (LOw Frequency ARray) – The Netherlands

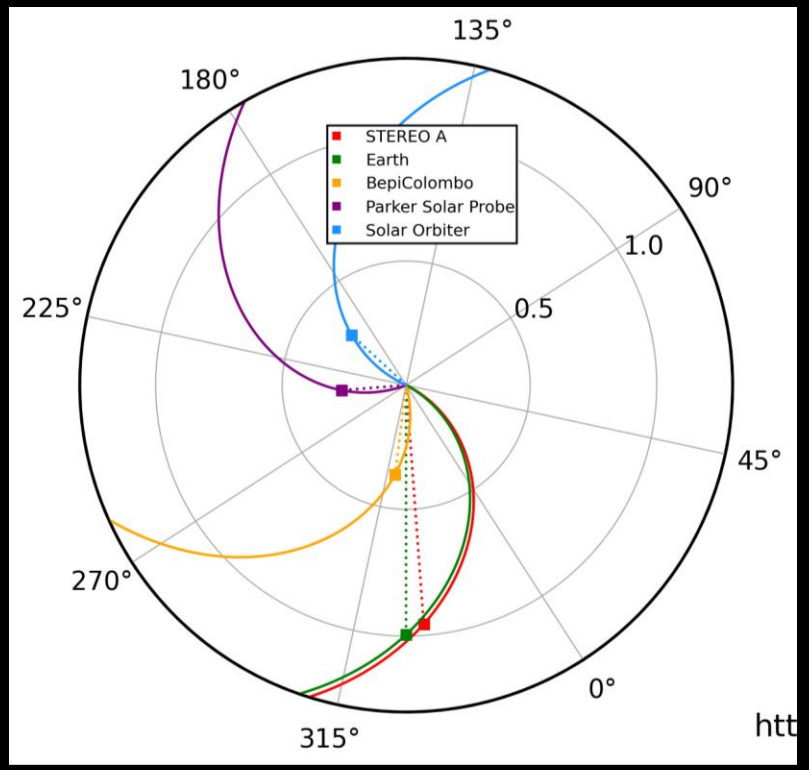
LOFAR stations in the Netherlands:
24 Core Stations
+ 18 Remote Stations

Maximum baseline: 80 km

3 October 2023 Type II Burst







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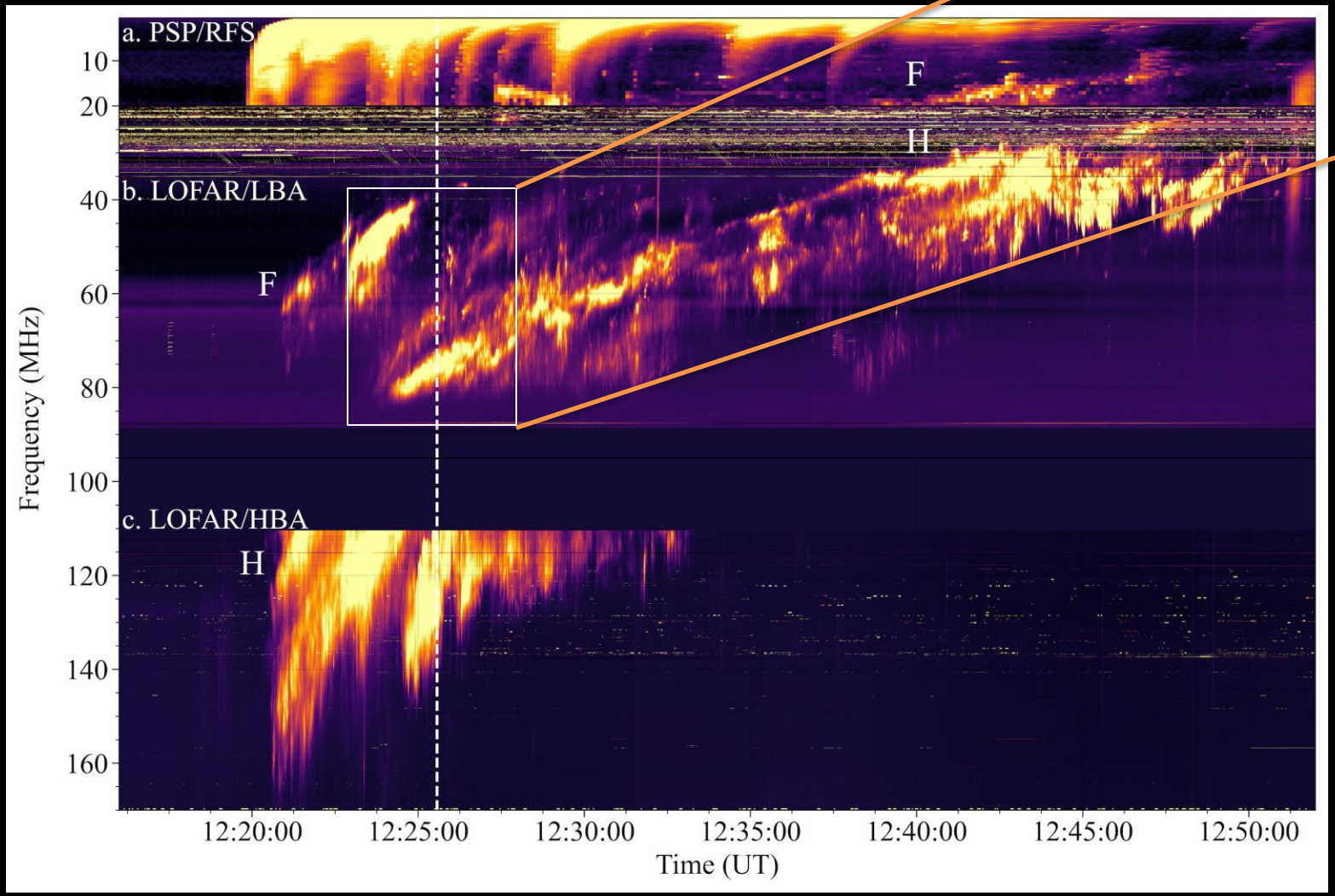
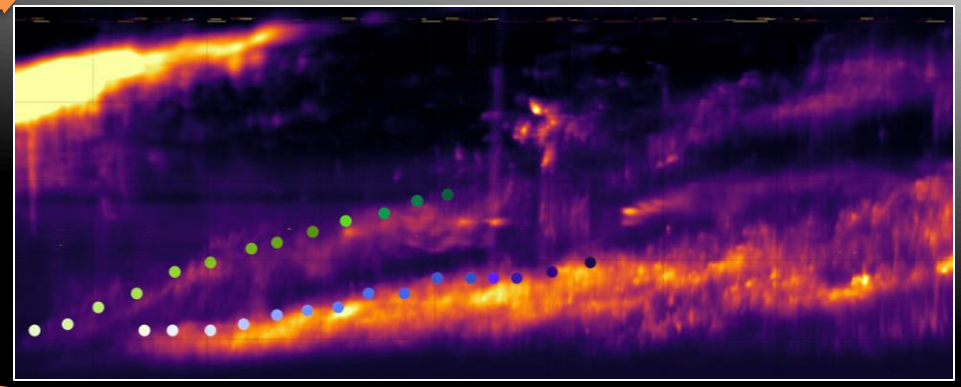
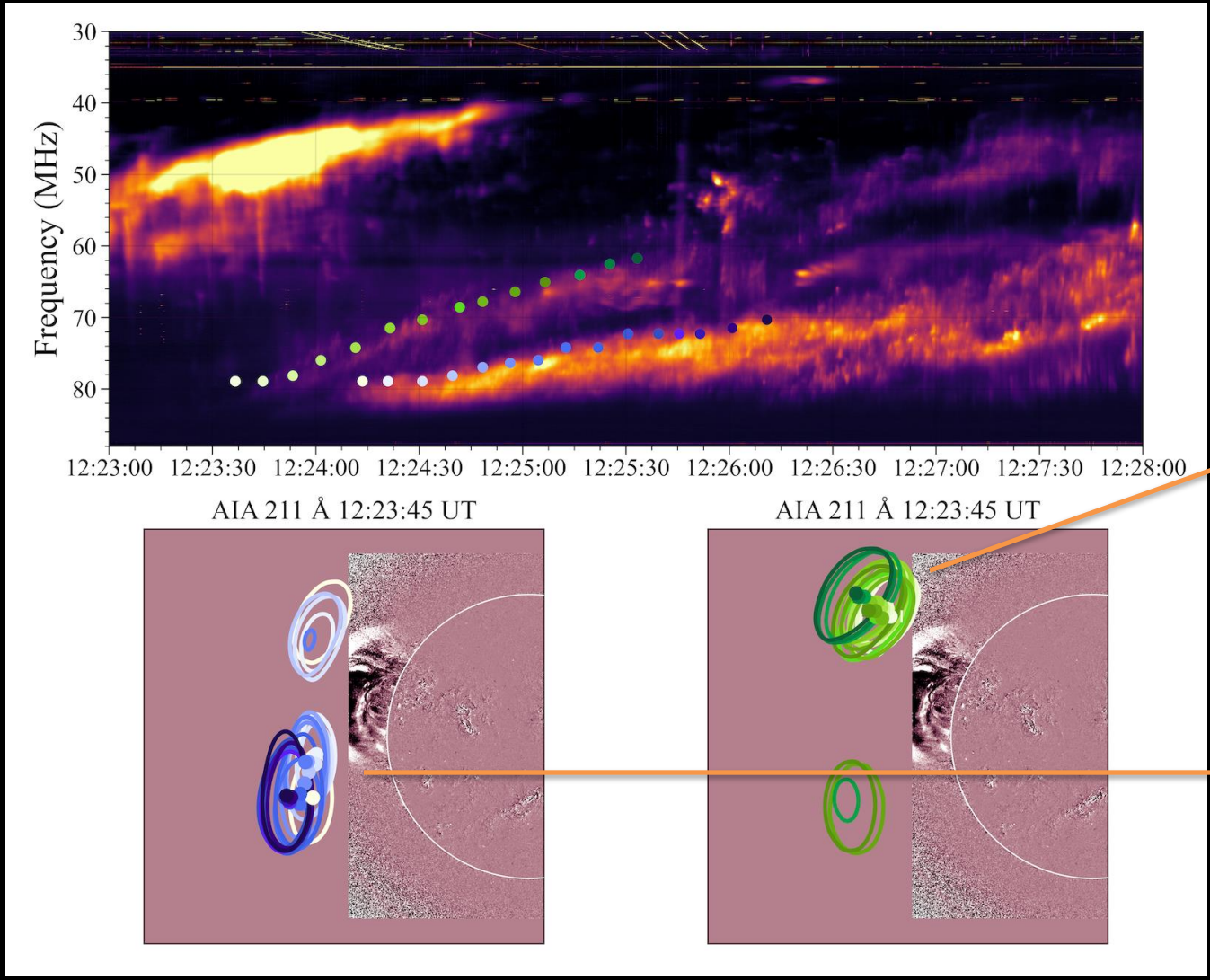




Two regions emitting Type II bursts – Low Resolution

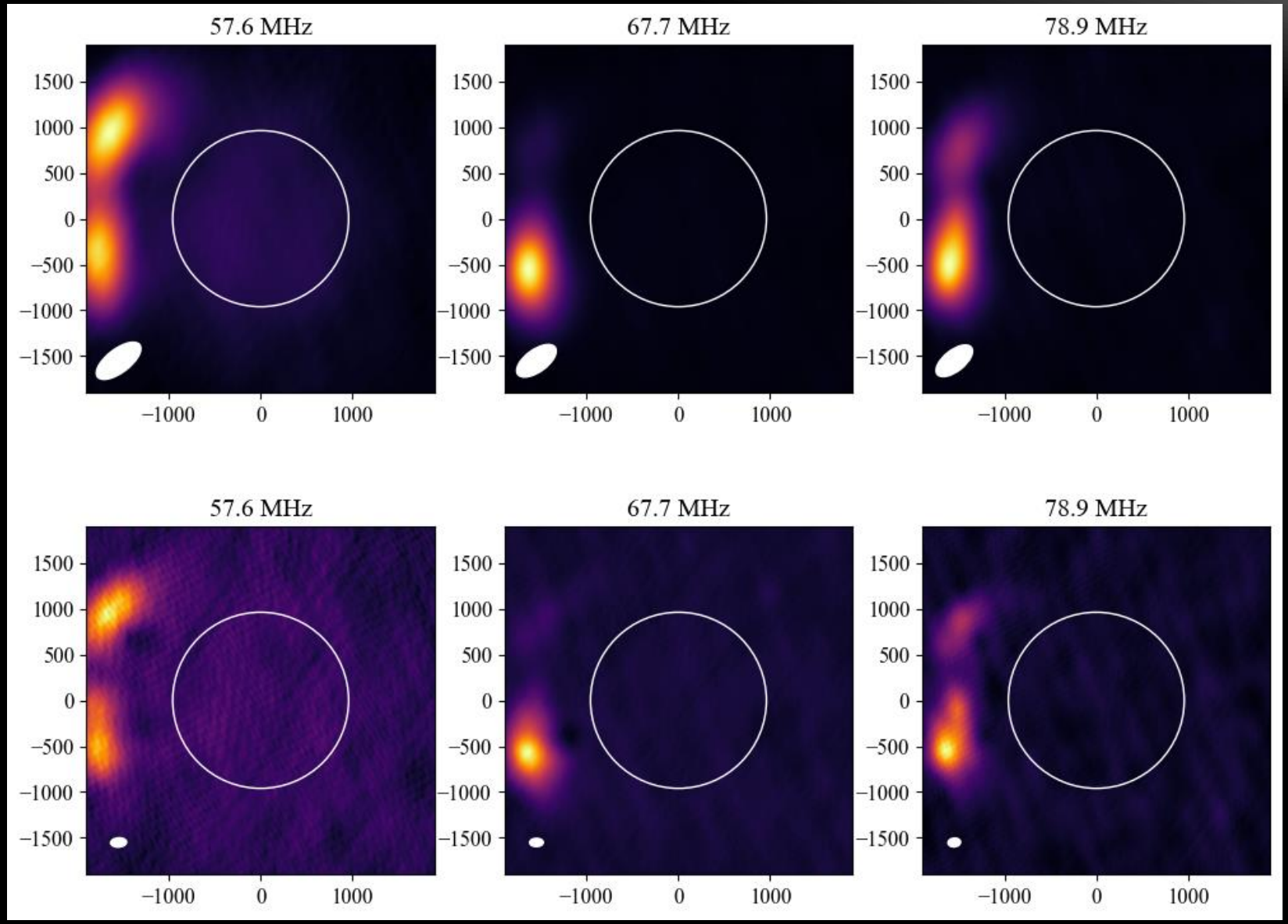


Fast low corona shock wave:

1400 km/s

1400 km/s

Type II Bursts – High-resolution Imaging

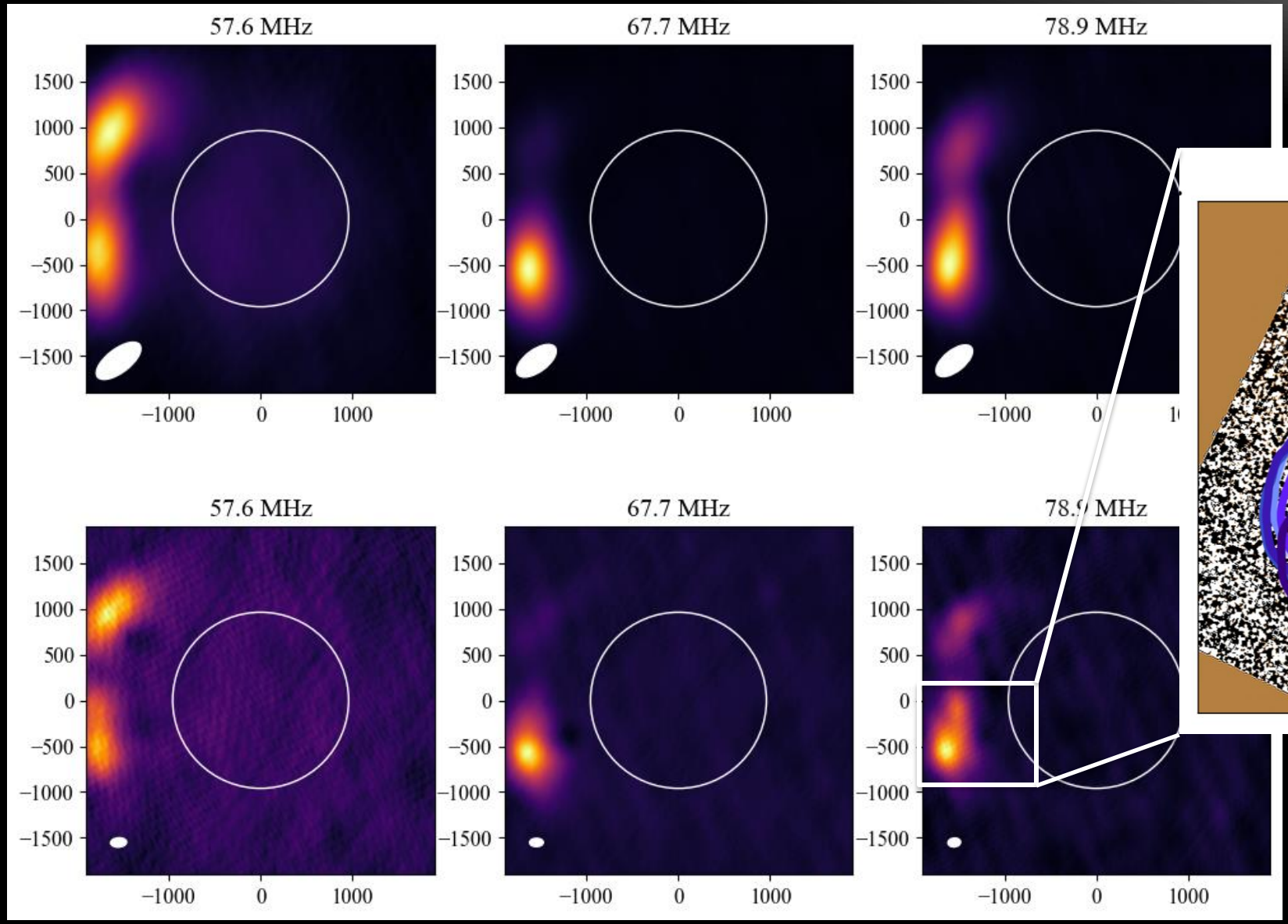


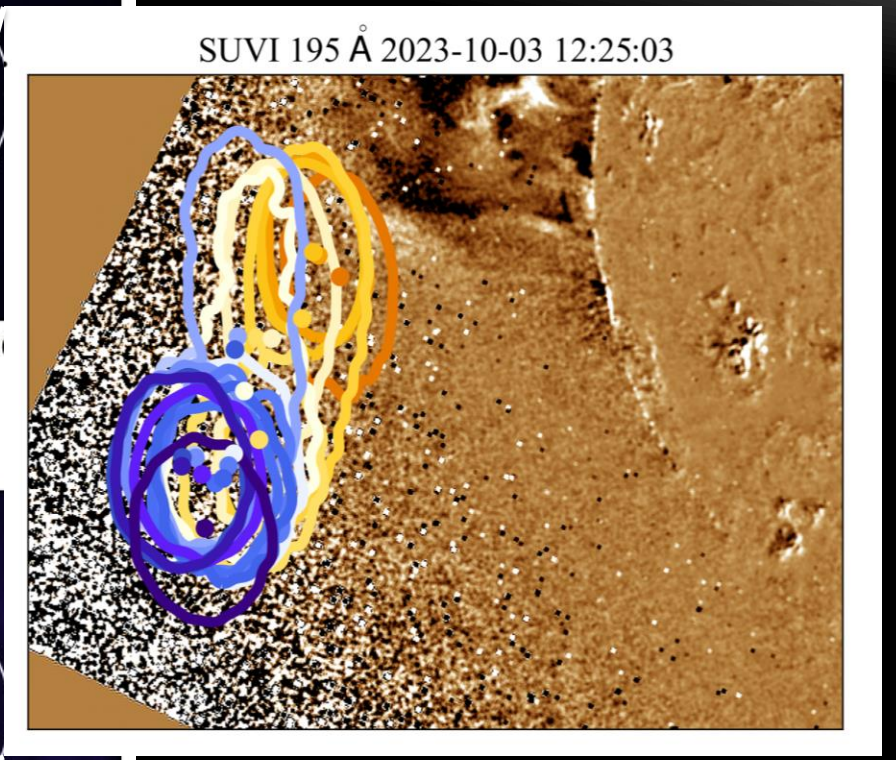
E-W: 15 km
N-S: 10 km

E-W: 20 km
N-S: 32 km

Morosan et al., A&A, 2025

Type II Bursts – High-resolution Imaging





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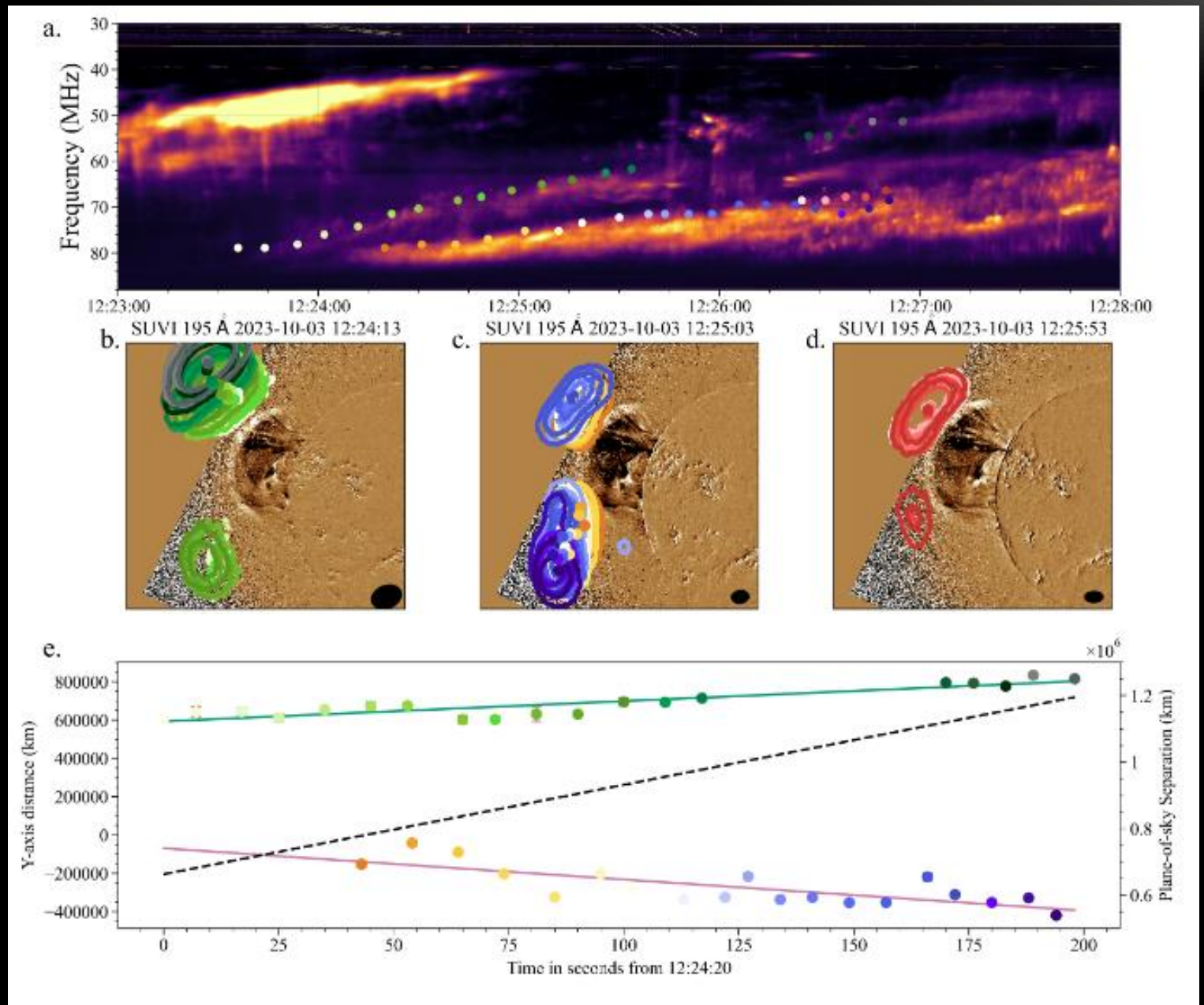
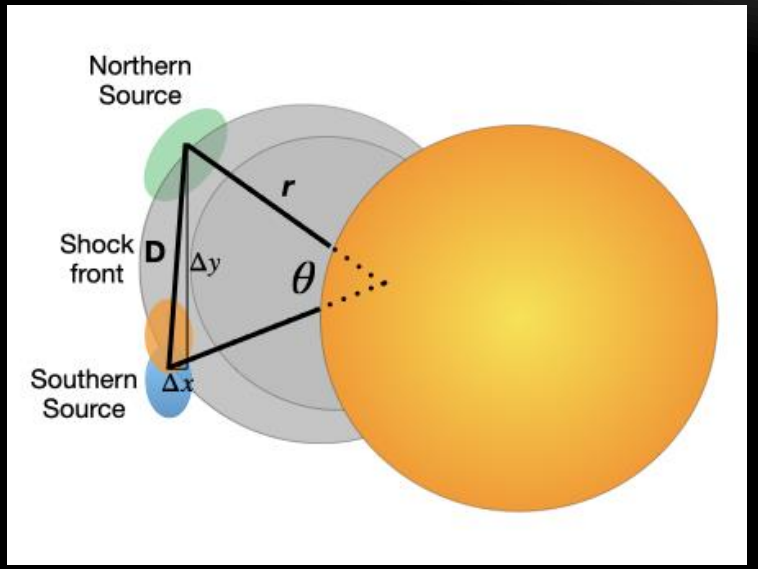
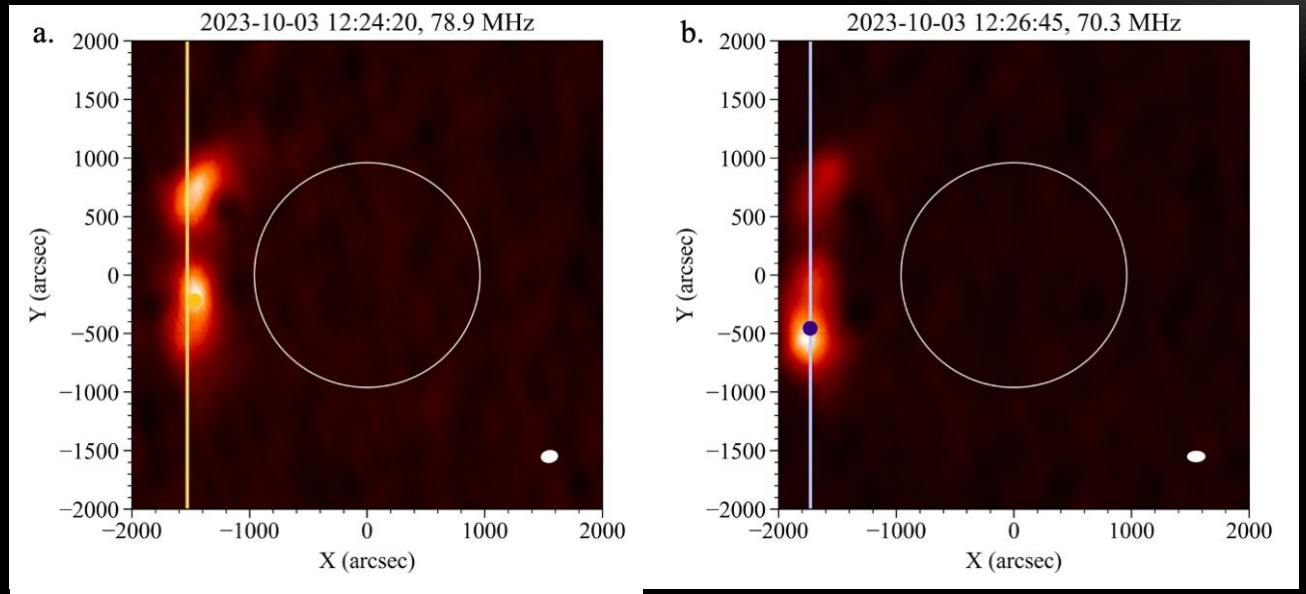
Type II Bursts – Shock Properties

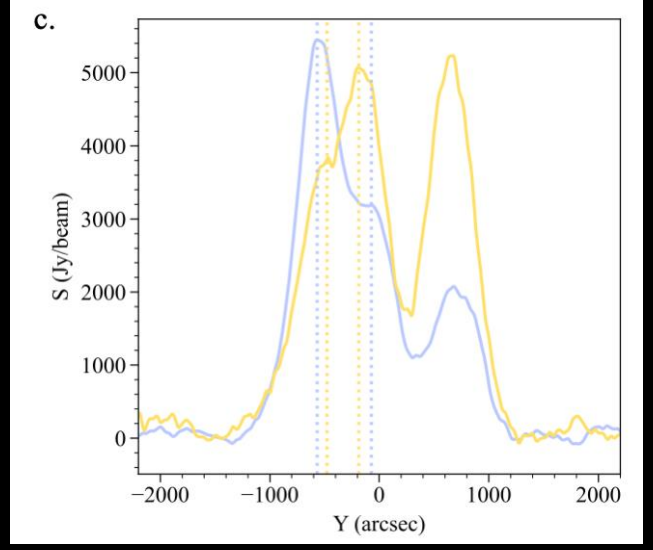




North and South sources separate at a rate of ≈2400 km/s

Type II Bursts – Shock Properties



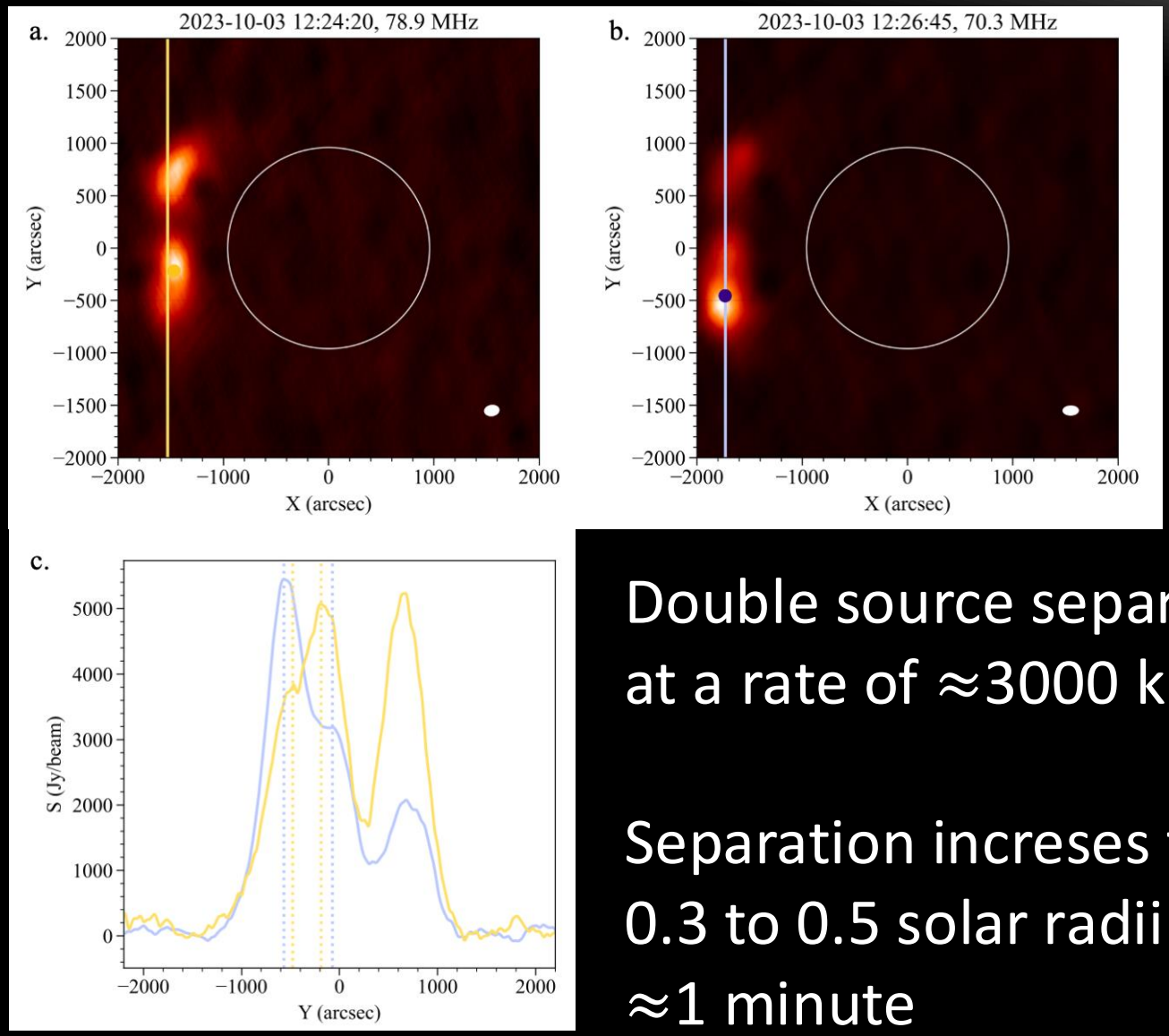


Double source separates at a rate of ≈3000 km/s

Separation increses from 0.3 to 0.5 solar radii in ≈1 minute

Morosan et al., A&A, 2025

Type II Bursts – Shock Properties



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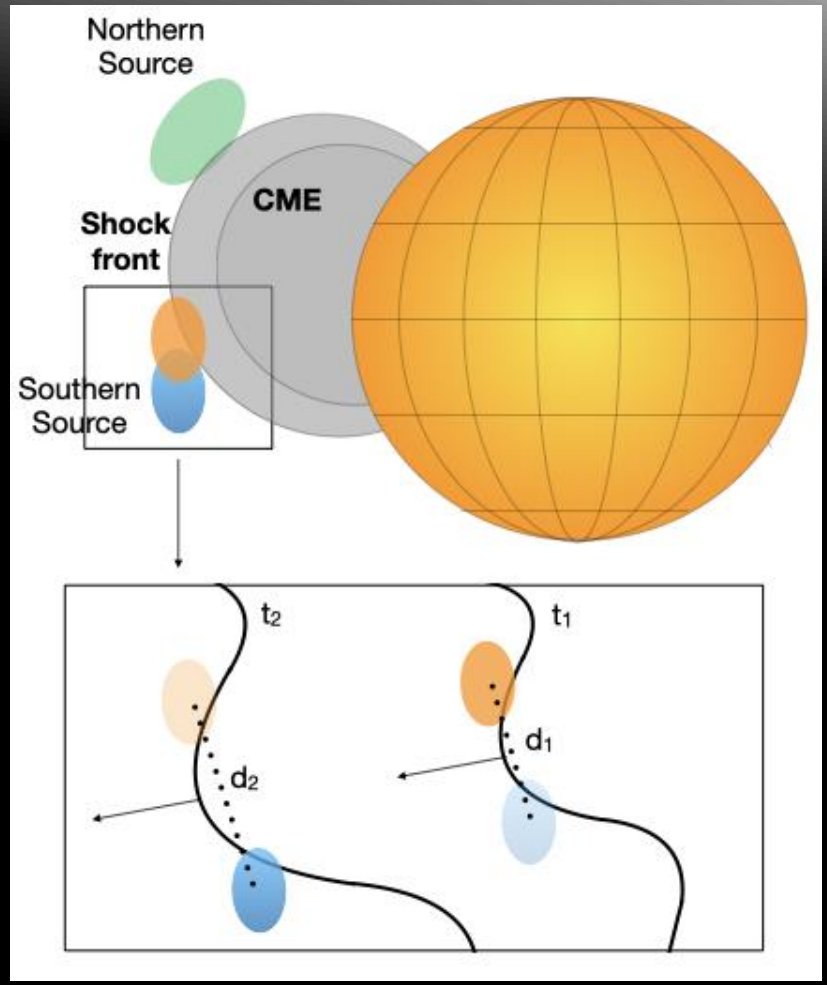

Shock corrugation or ambient medium inhomogeneity ≈10^5 km

Summary

- LOFAR is a powerful instrument to image the fine structure of low frequency solar radio bursts
- Currently, the only radio telescope capable of solar imaging with large baselines (tens of km)
- Increased spatial resolution is essential determining either the small-scale spatial properties of radio bursts; in this case related to coronal shocks or the structuring of the ambient medium