

Supplementary Materials:

Observation and Interpretation of Solar Radio Spike Repeating Burst Pairs

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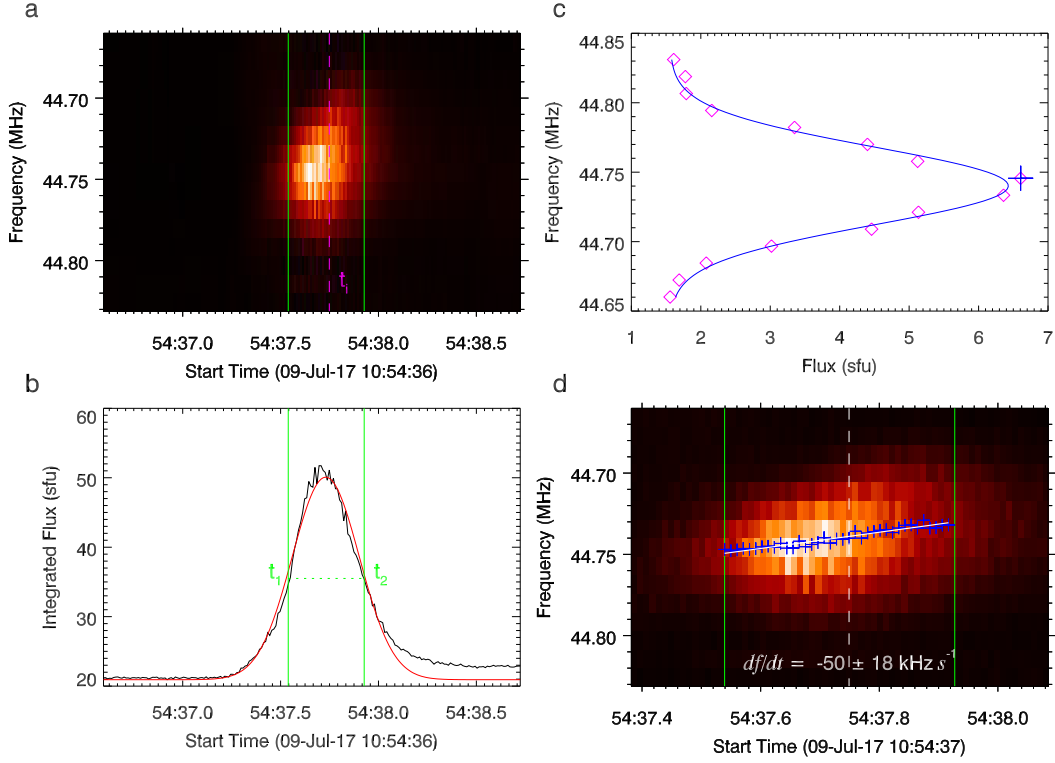
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Supplementary Fig. 1–3

Supplementary Table 1

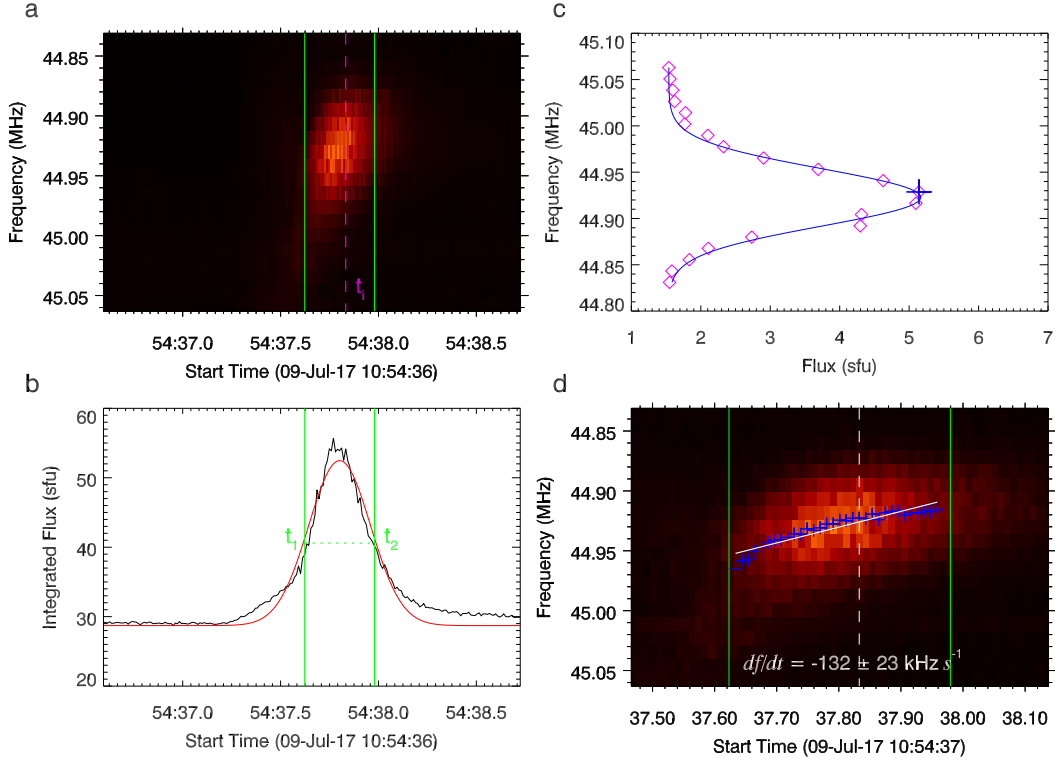
Supplementary Movie 1 is provided separately.

Supplementary Figure 1: Method to calculate the frequency drift rate of a radio burst.



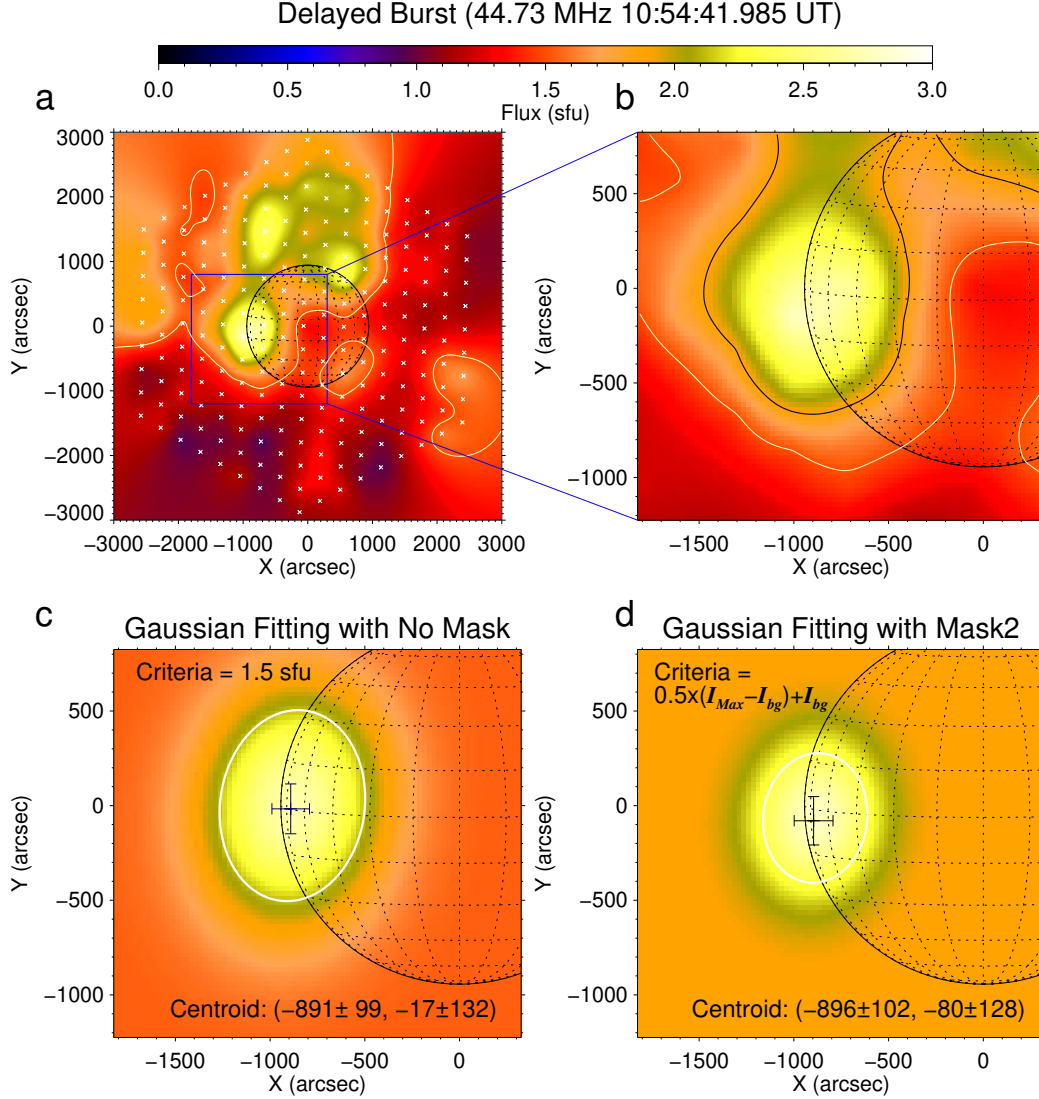
a Initial dynamic spectrum, **b** Integrated flux over frequency, **c** Frequency flux profile at time t_i , **d** Dynamic spectrum with fitted peak frequencies at each time from t_1 to t_2 and linear fitting to obtain the frequency drift rate (the white line). The vertical green lines indicate the time borders where the integrated flux exceeds its half maximum. The diamonds in panel b mark the flux over frequency at time t_i , and the blue curve shows the Gaussian fitting. The blue plus symbols indicate the peak frequencies.

Supplementary Figure 2: Method to calculate the frequency drift rate of another radio burst.



a Initial dynamic spectrum, **b** Integrated flux over frequency, **c** Frequency flux profile at time t_i , **d** Dynamic spectrum with fitted peak frequencies at each time from t_1 to t_2 and linear fitting to obtain the frequency drift rate (the white line). The vertical green lines indicate the time borders where the integrated flux exceeds its half maximum. The diamonds in panel **b** mark the flux over frequency at time t_i , and the blue curve shows the Gaussian fitting. The blue plus symbols indicate the peak frequencies.

Supplementary Figure 3: LOFAR image of the delayed burst at 10:54:42 UT and 44.73 MHz and 2D Gaussian fit results.



a Full disk LOFAR image. The white crosses show the phased array beam locations. The blue rectangle indicates the FOV of panel b. **b** Zoomed image used for Gaussian fitting, the black contour indicates the half maximum flux. **c** Restructured image based on the result from an elliptic Gaussian fitting without a mask of 1.5 sfu. **d** Restructured image based on the elliptic Gaussian fitting with a mask of $0.5 \times (I_{Max} - I_{bg}) + I_{bg}$. The white oval in panels **c** and **d** indicates the FWHM level, and the plus symbol with error bars marks the centroid of each burst.

Supplementary Table 1: Summary of statistical parameters used in box-and-whisker plots.*

Panel	Quantity	Dataset	N	5%	25%	50%	75%	95%
Fig.4(a)	Δt_E (s)	Total	350	0.19	0.25	0.31	0.43	0.68
		Image	162	0.17	0.26	0.32	0.41	0.67
	Δt_D (s)	Total	304	0.62	0.82	1.00	1.20	1.45
		Image	158	0.71	0.94	1.12	1.30	1.58
Fig.4(b)	Δt_s (s)	Total	241	3.47	4.03	4.23	4.39	4.52
		Image	121	3.97	4.13	4.28	4.41	4.51
Fig.4(c)	$\Delta t_E/\Delta t_D$	Total	241	0.18	0.25	0.30	0.38	0.56
		Image	121	0.17	0.23	0.28	0.33	0.52
Fig.4(d)	Δf_E (kHz)	Total	466	45.38	60.62	77.04	103.92	153.89
		Image	219	42.26	58.36	73.24	102.15	148.83
Fig.4(e)	Δf_D (kHz)	Total	393	49.84	67.36	81.44	105.85	153.74
		Image	197	46.62	62.07	79.29	107.26	149.52
Fig.4(f)	Δf_s (kHz)	Total	340	−8.24	1.64	6.16	9.54	15.43
		Image	158	−7.46	1.61	5.70	9.71	16.33
Fig.4(g)	I_{0E} (sfu)	Total	350	2.50	4.03	6.78	12.68	30.17
		Image	162	2.29	3.47	4.83	8.26	21.50
Fig.4(h)	I_{0D} (sfu)	Total	304	1.82	2.31	2.96	3.74	6.26
		Image	158	1.79	2.08	2.78	4.15	6.38
Fig.4(i)	I_{0D}/I_{0E}	Total	341	0.10	0.26	0.44	0.76	1.43
		Image	174	0.12	0.34	0.54	0.96	1.59
Fig.5(c)	$(df/dt)_E$ (kHz/s)	Total	404	−170.8	−68.2	−31.6	4.8	72.2
		Image	188	−119.2	−66.8	−33.8	0.3	41.9
Fig.5(d)	$(df/dt)_D$ (kHz/s)	Total	300	−21.7	−13.0	−7.8	−3.5	3.8
		Image	146	−22.5	−11.4	−6.5	−3.1	4.4

* **Definition of parameters.** Δt – Full Width at Half Maximum (FWHM) durations, where subscripts E and D denote earlier and delayed components (this rule applies to all following definitions). Δt_s – Δt_s – time separation between the peak fluxes of the E and D components; $\Delta t_E/\Delta t_D$ – time duration ratio; Δf_E , Δf_D – FWHM bandwidths; Δf_s – separation in frequency between the flux peaks of the E and D components; I_{0E} , I_{0D} – peak fluxes; $(df/dt)_E$, $(df/dt)_D$ – frequency drifts. “Total” – full bursts spanning 38–60 MHz; “Image” – bursts observed in 38–48 MHz that were successfully imaged with LOFAR.