
Supplementary information

**Precessing jet nozzle connecting to a
spinning black hole in M87**

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authors and unedited

Supplementary Table 1: Summary of EAVN, VLBA and EATING observations. ^a Total flux density. ^b Peak flux density after restoring 1-mas circular beam size. ^c Image noise. * The epochs with poor data quality which were excluded in the individual analysis in Fig. 2-(a). Total flux density and peak flux density have about 10% fractional uncertainties.

Obs. Code	MJD	Obs. Date (yyyy-mm-dd)	Obs. Freq. (GHz)	I_{total}^a (Jy)	I_{peak}^b (Jy beam ⁻¹)	I_{rms}^c (mJy beam ⁻¹)
EAVN						
r13104a	56396	2013-04-14	43	1.01 ± 0.10	0.73 ± 0.07	1.12
r13339b	56631	2013-12-05	22	1.70 ± 0.17	1.22 ± 0.12	0.65
r13360a	56652	2013-12-26	22	1.41 ± 0.14	0.91 ± 0.09	0.54
r14015a	56672	2014-01-15	22	1.43 ± 0.14	0.89 ± 0.09	0.58
r14061a	56718	2014-03-02	22	1.61 ± 0.16	0.96 ± 0.10	0.65
r14074a	56731	2014-03-15	22	1.69 ± 0.17	0.99 ± 0.10	0.55
r14106a	56763	2014-04-16	22	1.65 ± 0.16	0.99 ± 0.10	0.20
r14123a	56780	2014-05-03	22	1.64 ± 0.16	0.97 ± 0.10	0.21
r14153a	56810	2014-06-02	22	1.49 ± 0.15	0.88 ± 0.09	0.47
k14mk01a	56822	2014-06-14	22	1.49 ± 0.15	0.77 ± 0.08	1.33
k14mk03a	56901	2014-09-01	22	1.49 ± 0.15	0.99 ± 0.10	0.85
k14mk03b	56914	2014-09-14	22	1.49 ± 0.15	0.94 ± 0.09	0.76
k14mk04c	56965	2014-11-04	22	1.54 ± 0.15	0.99 ± 0.10	0.66
k14mk03d	57006	2014-12-15	22	1.19 ± 0.12	0.79 ± 0.08	0.69
k15mk02a	57145	2015-05-03	22	1.45 ± 0.14	0.96 ± 0.10	0.85
k15mk02c	57158	2015-05-16	22	1.42 ± 0.14	0.95 ± 0.10	0.78
k15mk02d	57159	2015-05-17	43	1.57 ± 0.16	1.05 ± 0.11	0.62
k16mk02a	57443	2016-02-25	22	2.16 ± 0.22	1.41 ± 0.14	0.31
k16mk02b	57444	2016-02-26	43	1.27 ± 0.13	0.95 ± 0.09	0.24
k16mk02c	57456	2016-03-09	22	2.15 ± 0.21	1.41 ± 0.14	0.36
k16mk02d	57457	2016-03-10	43	1.28 ± 0.13	0.92 ± 0.09	0.21
k16mk02f	57467	2016-03-20	43	1.27 ± 0.13	0.90 ± 0.09	0.17
k16mk02e	57468	2016-03-21	22	2.17 ± 0.22	1.42 ± 0.14	0.43
k16mk02g	57486	2016-04-08	22	2.09 ± 0.21	1.29 ± 0.13	0.28
k16mk02h	57487	2016-04-09	43	1.12 ± 0.11	0.82 ± 0.08	0.23
k16mk02i	57499	2016-04-21	22	2.07 ± 0.21	1.27 ± 0.13	0.35
k16mk02j	57500	2016-04-22	43	1.11 ± 0.11	0.79 ± 0.08	0.24
k16mk02k	57511	2016-05-03	22	1.95 ± 0.20	1.18 ± 0.12	0.31
k16mk02l	57513	2016-05-05	43	0.89 ± 0.09	0.69 ± 0.07	0.35
k16mk02n	57532	2016-05-24	22	1.96 ± 0.20	1.16 ± 0.12	0.31
k16mk02n	57533	2016-05-25	43	1.04 ± 0.10	0.75 ± 0.08	0.38
k16mk02o*	57540	2016-06-01	22	1.33 ± 0.13	0.87 ± 0.09	0.49
k16mk02p	57541	2016-06-02	43	0.91 ± 0.09	0.58 ± 0.06	0.25
k16mk02p	57551	2016-06-12	22	2.12 ± 0.21	1.22 ± 0.12	0.68
k16mk02r	57554	2016-06-15	43	0.87 ± 0.09	0.66 ± 0.07	0.45
k16mk02s*	57735	2016-12-13	22	2.12 ± 0.21	1.51 ± 0.15	0.40
k16mk02t*	57736	2016-12-14	43	1.80 ± 0.18	1.40 ± 0.14	0.28
k16mk02u	57763	2017-01-10	22	2.11 ± 0.21	1.50 ± 0.15	0.32
k16mk02v	57764	2017-01-11	43	1.89 ± 0.19	1.51 ± 0.15	0.34
k17mk02a	57776	2017-01-23	22	1.96 ± 0.20	1.41 ± 0.14	0.26
k17mk02b	57777	2017-01-24	43	1.93 ± 0.19	1.52 ± 0.15	0.25
k17mk02c	57798	2017-02-14	22	2.16 ± 0.22	1.52 ± 0.15	0.30
k17mk02d	57799	2017-02-15	43	1.87 ± 0.19	1.45 ± 0.15	0.25
k17mk02e	57811	2017-02-27	22	2.05 ± 0.20	1.45 ± 0.15	0.29
k17mk02f	57812	2017-02-28	43	1.80 ± 0.18	1.40 ± 0.14	0.26
a17077a	57830	2017-03-18	22	1.97 ± 0.20	1.29 ± 0.13	0.18
a17078a	57831	2017-03-19	43	1.53 ± 0.15	1.29 ± 0.13	0.30
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Obs. Code	MJD	Obs. Date (yyyy-mm-dd)	Obs. Freq. (GHz)	I_{total}^a (Jy)	I_{peak}^b (Jy beam ⁻¹)	I_{rms}^c (mJy beam ⁻¹)
a17086a	57839	2017-03-27	43	1.58 ± 0.16	1.27 ± 0.13	0.24
a17093a	57846	2017-04-03	22	1.98 ± 0.20	1.34 ± 0.13	0.26
a17094a	57847	2017-04-04	43	1.64 ± 0.16	1.34 ± 0.13	0.26
a17099a	57852	2017-04-09	43	1.55 ± 0.15	1.23 ± 0.12	0.31
a17104a	57857	2017-04-14	43	1.57 ± 0.16	1.30 ± 0.13	0.31
a17107a	57860	2017-04-17	22	1.90 ± 0.19	1.32 ± 0.13	1.16
a17108a	57861	2017-04-18	43	1.55 ± 0.16	1.27 ± 0.13	0.36
a17114a	57867	2017-04-24	22	1.81 ± 0.18	1.32 ± 0.13	0.38
a17115a	57868	2017-04-25	43	1.45 ± 0.15	1.24 ± 0.12	0.42
a17130a	57883	2017-05-10	22	1.88 ± 0.19	1.34 ± 0.13	0.23
a17131a	57884	2017-05-11	43	1.52 ± 0.15	1.23 ± 0.12	0.33
a17146a	57899	2017-05-26	43	1.44 ± 0.14	1.19 ± 0.12	0.36
k17mk02g	58122	2018-01-04	22	1.77 ± 0.18	1.27 ± 0.13	0.34
k17mk02h	58123	2018-01-05	43	1.39 ± 0.14	1.10 ± 0.11	0.27
k18mk02a	58140	2018-01-22	22	1.73 ± 0.17	1.28 ± 0.13	0.47
k18mk02b	58143	2018-01-25	43	1.26 ± 0.13	1.01 ± 0.10	0.32
k18mk02c	58159	2018-02-10	22	1.64 ± 0.16	1.17 ± 0.12	0.32
k18mk02d	58160	2018-02-11	43	1.35 ± 0.13	1.02 ± 0.10	0.30
k18mk02e	58172	2018-02-23	22	1.81 ± 0.18	1.22 ± 0.12	0.28
k18mk02f	58173	2018-02-24	43	1.36 ± 0.14	1.03 ± 0.10	0.28
a18068a	58186	2018-03-09	22	1.58 ± 0.16	1.09 ± 0.11	0.25
a18069a	58187	2018-03-10	43	1.27 ± 0.13	0.99 ± 0.10	0.21
a18085a	58203	2018-03-26	22	1.45 ± 0.15	1.08 ± 0.11	0.30
a18087a	58205	2018-03-28	43	1.26 ± 0.13	0.96 ± 0.10	0.26
a18101a	58219	2018-04-11	43	1.23 ± 0.12	0.96 ± 0.10	0.30
a18111a	58229	2018-04-21	43	1.25 ± 0.12	0.94 ± 0.09	0.28
a18117a	58235	2018-04-27	43	1.29 ± 0.13	0.96 ± 0.10	0.29
a18118a	58236	2018-04-28	22	1.22 ± 0.12	0.83 ± 0.08	0.27
a18123a	58241	2018-05-03	43	0.89 ± 0.09	0.67 ± 0.07	0.30
a18127a	58245	2018-05-07	43	1.15 ± 0.12	0.89 ± 0.09	0.54
a18128a*	58246	2018-05-08	22	1.49 ± 0.15	1.01 ± 0.10	0.29
k18mk02o	58272	2018-06-03	22	1.48 ± 0.15	0.94 ± 0.09	0.42
k18mk02p	58274	2018-06-05	43	1.17 ± 0.12	0.81 ± 0.08	0.38
k18mk02q	58475	2018-12-23	22	1.48 ± 0.15	0.88 ± 0.09	0.26
k18mk02r	58478	2018-12-26	43	1.05 ± 0.11	0.70 ± 0.07	0.25
k18mk02r	58496	2019-01-13	22	1.40 ± 0.14	0.88 ± 0.09	0.18
k18mk02t	58497	2019-01-14	43	1.04 ± 0.10	0.70 ± 0.07	0.24
a19mk02a	58513	2019-01-30	22	1.26 ± 0.13	0.72 ± 0.07	0.20
a19mk02b	58515	2019-02-01	43	1.04 ± 0.10	0.68 ± 0.07	0.24
a19mk02c	58531	2019-02-17	43	1.08 ± 0.11	0.71 ± 0.07	0.25
a19051a	58534	2019-02-20	43	1.04 ± 0.10	0.67 ± 0.07	0.82
a19mk02f	58543	2019-03-01	43	1.03 ± 0.10	0.69 ± 0.07	0.29
a19kh01a	58564	2019-03-22	43	0.99 ± 0.10	0.67 ± 0.07	0.29
a19kh01c	58571	2019-03-29	43	1.03 ± 0.10	0.70 ± 0.07	0.21
a19kh01f	58585	2019-04-12	43	1.03 ± 0.10	0.70 ± 0.07	0.32
a19mk02h	58600	2019-04-27	43	1.04 ± 0.10	0.70 ± 0.07	0.28
a19mk02j*	58610	2019-05-07	43	1.09 ± 0.11	0.75 ± 0.07	0.28
a19mk02l	58628	2019-05-25	43	1.11 ± 0.11	0.75 ± 0.08	0.31
a19mk02q	58823	2019-12-06	22	1.64 ± 0.16	1.03 ± 0.10	0.31
a19mk02r	58838	2019-12-21	22	1.57 ± 0.16	1.02 ± 0.10	0.28
a2015a	58878	2020-01-30	22	1.57 ± 0.16	0.99 ± 0.10	0.57
a2011a	58924	2020-03-16	43	1.19 ± 0.12	0.82 ± 0.08	0.24
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Obs. Code	MJD	Obs. Date (yyyy-mm-dd)	Obs. Freq. (GHz)	I_{total}^a (Jy)	I_{peak}^b (Jy beam ⁻¹)	I_{rms}^c (mJy beam ⁻¹)
a2011b	58929	2020-03-21	43	1.19 ± 0.12	0.81 ± 0.08	0.32
a2011e	58948	2020-04-09	43	1.21 ± 0.12	0.82 ± 0.08	0.23
a2011f	58953	2020-04-14	43	1.07 ± 0.11	0.75 ± 0.08	0.35
a2011g	58963	2020-04-24	43	1.20 ± 0.12	0.82 ± 0.08	0.26
a2011h	58973	2020-05-04	43	1.24 ± 0.12	0.83 ± 0.08	0.45
a2011i	58983	2020-05-14	43	1.14 ± 0.11	0.79 ± 0.08	0.29
a2011j	58996	2020-05-27	43	1.19 ± 0.12	0.84 ± 0.08	0.29
a2029b	59209	2020-12-26	43	0.95 ± 0.09	0.65 ± 0.06	0.25
a2114d	59312	2021-04-08	43	1.38 ± 0.14	0.91 ± 0.09	0.38
a2114f	59348	2021-05-14	43	1.36 ± 0.14	0.90 ± 0.09	0.34
a2114g	59362	2021-05-28	43	1.12 ± 0.11	0.77 ± 0.08	0.40
a2213c	59636	2022-02-26	43	1.10 ± 0.11	0.74 ± 0.07	0.32
a2213d	59643	2022-03-05	43	0.98 ± 0.10	0.58 ± 0.06	0.36
a2214b	59661	2022-03-23	43	1.23 ± 0.12	0.85 ± 0.09	0.42
a2213f	59668	2022-03-30	43	1.12 ± 0.11	0.72 ± 0.07	0.45
a2213g	59679	2022-04-10	43	0.90 ± 0.09	0.62 ± 0.06	0.34
a2213i	59692	2022-04-23	43	1.01 ± 0.10	0.66 ± 0.07	0.35
a2213k	59709	2022-05-10	43	1.00 ± 0.10	0.69 ± 0.07	0.34
a2213l	59715	2022-05-16	43	0.95 ± 0.10	0.67 ± 0.07	0.27
a2213m	59726	2022-05-27	43	0.99 ± 0.10	0.68 ± 0.07	0.30
VLBA						
BJ031B	51643	2000-04-09	43	1.16 ± 0.12	0.81 ± 0.08	0.26
BW054A*	51988	2001-03-20	43	0.85 ± 0.08	0.65 ± 0.06	1.86
BW054B	52194	2001-10-12	43	1.07 ± 0.11	0.78 ± 0.08	0.95
BU021	52559	2002-10-12	43	0.98 ± 0.10	0.68 ± 0.07	0.46
BW070	53099	2004-04-04	43	0.85 ± 0.09	0.58 ± 0.06	0.62
BW082G	53930	2006-07-14	43	1.58 ± 0.16	1.08 ± 0.11	0.41
BW088A	54127	2007-01-27	43	1.29 ± 0.13	0.84 ± 0.08	0.34
BW088B	54148	2007-02-17	43	1.59 ± 0.16	1.06 ± 0.11	0.48
BW088D	54172	2007-03-13	43	1.49 ± 0.15	0.90 ± 0.09	0.23
BW088E	54193	2007-04-03	43	1.25 ± 0.13	0.81 ± 0.08	0.22
BW088F	54213	2007-04-23	43	1.27 ± 0.13	0.83 ± 0.08	0.17
BW088G	54229	2007-05-09	43	1.40 ± 0.14	0.89 ± 0.09	0.15
BW088H	54253	2007-06-02	43	1.37 ± 0.14	0.78 ± 0.08	0.17
BW088I	54272	2007-06-21	43	1.20 ± 0.12	0.70 ± 0.07	0.19
BW088J	54296	2007-07-15	43	1.23 ± 0.12	0.73 ± 0.07	0.21
BW088K	54316	2007-08-04	43	1.04 ± 0.10	0.62 ± 0.06	0.20
BW088L	54338	2007-08-26	43	1.05 ± 0.10	0.62 ± 0.06	0.25
BW088U	54486	2008-01-21	43	1.58 ± 0.16	1.10 ± 0.11	0.17
BW090A	54491	2008-01-26	43	1.32 ± 0.13	0.84 ± 0.08	0.14
BW090B	54496	2008-01-31	43	1.55 ± 0.15	1.04 ± 0.10	0.17
BW090E	54511	2008-02-15	43	1.61 ± 0.16	1.14 ± 0.11	0.20
BW090G	54521	2008-02-25	43	1.53 ± 0.15	1.11 ± 0.11	0.24
BW090H	54527	2008-03-02	43	1.86 ± 0.19	1.27 ± 0.13	0.25
BW090J	54537	2008-03-12	43	2.00 ± 0.20	1.44 ± 0.14	0.16
BW090K	54544	2008-03-19	43	1.87 ± 0.19	1.35 ± 0.14	0.16
BW090L	54549	2008-03-24	43	1.96 ± 0.20	1.38 ± 0.14	0.16
BW090N	54561	2008-04-05	43	1.94 ± 0.19	1.35 ± 0.14	0.24
BW092B	54903	2009-03-13	43	1.12 ± 0.11	0.73 ± 0.07	0.19
BW093A	55214	2010-01-18	43	1.57 ± 0.16	1.04 ± 0.10	0.26
BW093B	55294	2010-04-08	43	1.61 ± 0.16	1.10 ± 0.11	0.40
BW093D	55317	2010-05-01	43	1.53 ± 0.15	1.04 ± 0.10	0.42
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BW093E	55331	2010-05-15	43	1.49 ± 0.15	1.04 ± 0.10	0.93
BW095B	55605	2011-02-13	43	1.47 ± 0.15	1.07 ± 0.11	0.19
BW098A	56304	2013-01-12	43	1.84 ± 0.18	1.26 ± 0.13	0.00
BW106A	56446	2013-06-03	43	1.59 ± 0.16	1.07 ± 0.11	0.17
BH0186C	56742	2014-03-26	43	1.63 ± 0.16	1.13 ± 0.11	0.75
BH0186D	56785	2014-05-08	43	1.50 ± 0.15	1.04 ± 0.10	0.40
BW115A	57048	2015-01-26	43	1.24 ± 0.12	0.81 ± 0.08	0.06
BW115D	57461	2016-03-14	43	1.60 ± 0.16	1.05 ± 0.11	0.08
BW115H	57488	2016-04-10	43	1.39 ± 0.14	0.94 ± 0.09	0.07
BG251A	57878	2017-05-05	24	1.75 ± 0.18	1.16 ± 0.12	0.12
BG251A	57878	2017-05-05	43	1.53 ± 0.15	1.16 ± 0.12	0.33
BG250A	58236	2018-04-28	24	1.22 ± 0.12	0.83 ± 0.08	0.27
BG250A	58236	2018-04-28	43	1.09 ± 0.11	0.84 ± 0.08	0.11
BG250B1	58263	2018-05-25	24	1.07 ± 0.11	0.75 ± 0.07	0.24
BG250B1	58263	2018-05-25	43	1.02 ± 0.10	0.69 ± 0.07	0.12
BK226	58918	2020-03-10	43	0.98 ± 0.10	0.71 ± 0.07	0.09
EATING						
a17107a	57860	2017-04-17	22	1.96 ± 0.20	1.72 ± 0.17	1.02
a19mk02q	58823	2019-12-06	22	1.64 ± 0.16	1.03 ± 0.10	0.25
a19mk02r	58838	2019-12-21	22	1.57 ± 0.16	1.02 ± 0.10	0.24
a2015a	58878	2020-01-30	22	1.57 ± 0.16	0.99 ± 0.10	0.42