M2O Telecom, No. 21

JWST Proposal approved: ToO observations of HMYSO accretion bursts, triggered based on maser flares, has been approved 24.9 hours of cycle 1 observing time (PI Alessio Caratti o Garatti).

JCMT Collaboration: The JCMT commissioners have approved a collaboration between the JCMT Transients team and M2O. Policy text finalised and activity started (See Reports).

Cumulative M2O source list: Source lists haven now been provided by 7 single-dish observatories, enabling cross-check with eachother, with the MaserDB and with other projects. A plot of the sky coverage has been generated, along with some basic stats (see Reports). Acceptable to place on the M2O website?

G358 6.7 GHz Movie paper progress: Final epoch of G358 6.7 GHz VLBI data (V581B) cannot produce images and must be abandoned. But the topics of the paper are safe (see Reports).

New maser flares: None reported this month

1 Activity since the previous Telecom

- **SamePage:** +3 (Zsófia Szabó, Sergey Khaibrakhmanov and Vardan Elbakyan), total 76 members.
- **Papers accepted:** +0; Total: 16
- **Papers in revision:**
- **Updates on papers in prep:**
  - Bayandina et al., VLA masers in G358, first draft ready
  - Burns et al., 6.7 GHz VLBI movie in G358. Drafting and further analyses (see Telecom18 Report)
  - Burns et al., VLBI maps of rare maser lines in G358. (See Telecom15 Report)
  - Orosz et al., 7.6 and 7.8 GHz methanol masers in G358, aiming for ApJL
  - Hirota et al., G24.33+0.14 ALMA follow-up; pre- and post- maser flare phases. (see Reports)
  - Olech et al., VLBI images of G24.33 during its maser flare.
  - Gray et al., Two additions to the maser flare series: compression and skyplane overlap scenarios.

- **M2O targets:**

Name	Maser [GHz]	Pre-burst Flux [Jy]	Max Flux [Jy]	Current Flux [Jy]	Reported by	Reobserved by	Status
G359.617-0.251	6.7	120	200	100	Yonekura	Ib, Hh,	stable
Orion S6	6.7	3.1	9	2	Yonekura	Ib, Tr, Sz, Hh	variable
G85.411+0.002	6.7	12	95	95	Yonekura	Ib, Ef, Sz, Tr, Hh, Ky, Vs	decreasing
G33.641-0.228	6.7	-	236	43	Bringfried	Hh, Ib, Vs	eruptive
IRAS 16293-2422	22	-	30k	-	Sunada, Mc	Vr, Mc, Hh, Sz, Ib	-
NGC2071	22	1k	7k	920	Sunada, Hh	Vr, Hh, Sz, Ib	post-burst
G53.22-0.08	22	3	800	30	Sunada	Vr, Hh, Ib	post-burst
G358.93-0.03	6.7	5	1000	20	Yonekura	Hh, Ib	decreasing
G24.33+0.14	6.7	-	800	7	Torun	Hh, Ib, Vs	post-burst
G25.65+1.05	22	-	60k	2150	Volvach	Hh, Sz	post-burst
G034.196-0.592	22	-	120	120	Ladeyschikov	Sz, Oa, Hh	?
G35.200.74	22	600	4k	4k	Volvach	Sz, Hh, Ib	?

(Ib = Ibaraki) (Tr = Torun) (Sz = Simeiz) (Hh = HartRAO) (Ef = Effelsberg) (Ky = KVN Yonsei) (Vs = Ventspil) (Vr = VERA stations) (Mc = Medicina) (Ps = Puschino) (Oa = OAO-WFC)

- **New observing proposals:** None this month
- **Active trigger proposals:**

Array	Code	Grade	Hours granted target x epoch x hour	Hours remaining	Active period	Resubmit deadline
EVN	EB083	1.2 / 5.0 (0 is best)	(3x2x8)x2 bands = 96	96	15/SEP/20 - 15/SEP/21	1/JUN/21
KaVA	EAVN21A-213	7.6 / 10.0 (10 is best)	2 x 1 x 8 = 16	16	01/FEB/21 - 01/SEP/21	1/JUN/21
EAVN	EAVN21A-214	8.3 / 10.0 (10 is best)	1 x 2 x 8 = 16	16	01/FEB/21 - 01/SEP/21	1/JUN/21
LBA	V581	4.1 / 5.0 (5 is best)	96	88	01/OCT/20 - 01/OCT/21	16/JUN/21
VLBA	BB418	1.82 / 10.0 (0 is best)	48	48	01/AUG/20 - 01/AUG/21	01/FEB/21
Subaru	S20B0051N	accepted	0.5*2 or 1 night	0.5*2 or 1 night	01/AUG/20 - 01/JAN/21	-
JWST	01906	1st quintile	24.9	24.9	Cycle 1	-

- **Follow-up observations conducted (see Record Keeping):** None this month

2 Reports

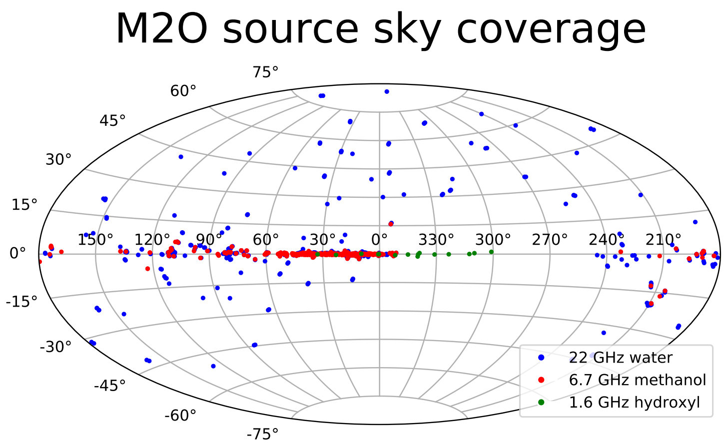
Short reports on specific activities, please send me an email (ross.burns@nao.ac.jp) in advance if you have something to report in an upcoming telecom.

M2O cumulative source list: Ross Burns

As mentioned in the previous newsletter, the combined source lists of essentially all single-dish monitoring stations participating in the M2O have provided their source lists. These have now been compiled and plotted below.

The source lists of individual stations will not be made public, and neither will I distribute them on behalf of anyone else. If you are interested in a particular source I urge you to raise discussion of it in SamePage and to ask if there are monitoring stations who pursue this source - rather than asking for their full source lists and checking for yourself.

The plot below does not reveal much detailed information itself, since it is not easy to make out the precise coordinates of sources from the figure. However it does serve as a nice visual of our sky coverage. **I would like to ask all monitoring stations if they agree for this figure to be used on the website and in presentations (please dont use this figure until then!).**



Sky-map of sources monitored by M2O stations (ver 1).

The general stats of the combined M2O monitoring efforts are as follows:
1129 total number of masers in all bands
22 GHz water masers: 411 total
6.7 GHz methanol masers: 671 total
1.6 GHz hydroxyl masers: 15 total
Will crossmatch for duplicates and compare with the JCMT fields and MaserDB.

M2O-JCMT Transients collaboration: Ross Burns

The JCMT commissioners have approved a collaboration between the JCMT Transients team and M2O.

Activity had already started on SamePage, and also with an introductory Zoom call earlier this month to give background context from both sides of the collaboration and also to discuss the main targets of interest, which is expected to be dominated by low mass YSOs. The presentation files can be found at the bottom of the Document on SamePage, at WorkSpace > Facilities > JCMT M2O collaboration. Furthermore Dmitry Ladeyschikov cross-matched the JCMT fields with the MaserDB, finding quite a large number of positive matches. Dmitry mapped these on the JCMT fields, please see the document "Maser_Atlas.pdf" which is in the chat section. Keep an eye on this SamePage chat section for further details and upcoming activity.

One recurring discussion point so far has been the idea of conducting new maser surveys of the JCMT fields. I'd like to call for observatories to consider if they have the time and resources to conduct maser surveys of these regions in their available time. Or if instead we should submit regular proposals to radio telescopes to obtain the time needed to do this work.

Below is the final version of the collaboration policy text that was approved by the JCMT commissioners this month.

M2O-JCMT Transients collaboration policy text (approved version)

The M2O and JCMT-Transient teams are both interested in solving similar problems related to accretion variability. The two teams are obtaining complementary datasets monitoring maser and dust continuum emission. Coordination between the two teams will help to identify variability and explain that variability with physical models that accounts for both types of emission. Collaborations may include triggering observations of specific variables identified by the other program, continuum surveys of regions covered by the M2O team, and the reverse.

For events initially discovered by the M2O team, the JCMT team will (a) not publish any follow-up papers until after the discovery is published or one year from being informed, whichever is earlier, and (b) ensure that any published JCMT observations that flows directly from that discovery will acknowledge the M2O contribution by including those M2O team members who are responsible for the discovery. The M2O team will have the same policy for JCMT discoveries and authorship. Typically we would expect the co-authorship from M2O to be 3-5 people and be expected to include the person most responsible for data reduction and the person most responsible for the discovery. The co-authorship requirement would apply only to papers that flow from the discovery and would not apply to any global analyses that happen to include the object as part of a larger sample. The co-authorship requirement would apply only to data obtained through advanced knowledge of the complementary team and would not apply to data obtained after publication.

Both teams appreciate the need to recognize researchers who are doing the work, and both teams respect the needs and discoverers from the other team. This policy is intended to facilitate science by encouraging open discussions that protect the people responsible for the scientific discoveries.

Data reduction of V581B (G358 and G359) and paper thoughts: Ross Burns

The final 6.7 GHz observation of G358 was conducted in August 2020, well after the maser flare had ended, and during its slow return to pre-flare fluxes. The correlated data arrived recently but unfortunately, the data (LBA, 5 stations but many problems) cannot produce images of the G358 masers due to the lack of short baselines and the extended, low flux density of the G358 methanol masers.

Fortunately, we already have one processed image of the maser distribution in the post-flare phase (see next page) which showed that the maser ring (seen in the first 5 VLBI images) had disappeared. Since the end of the flare, the spectrum has not shown any significant changes. Therefore we can expect that the maser ring has remained gone and will not come back unless there is another event.

The conclusion is that the inability to use V581B is unfortunate, but not a fatal issue at all. I will continue drafting the paper on the ring expansion, rotation kinematics and spiral arms.

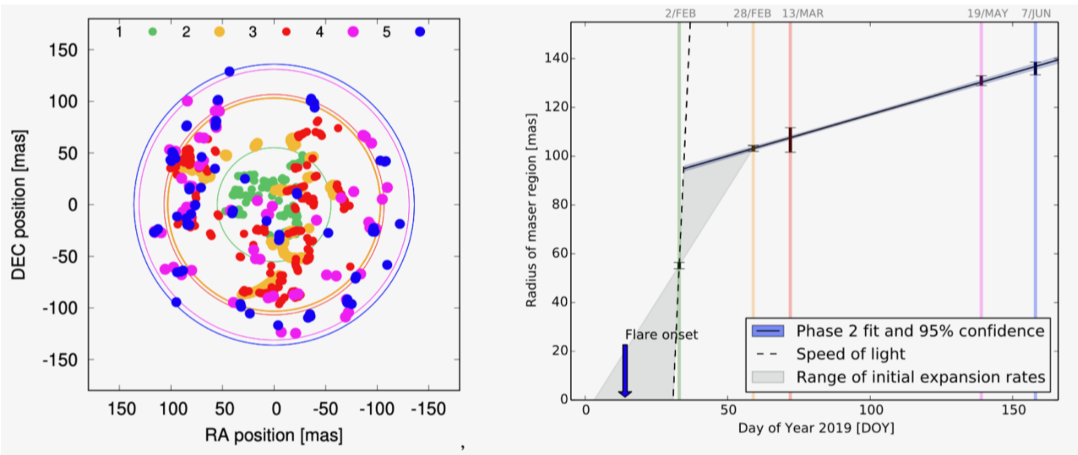
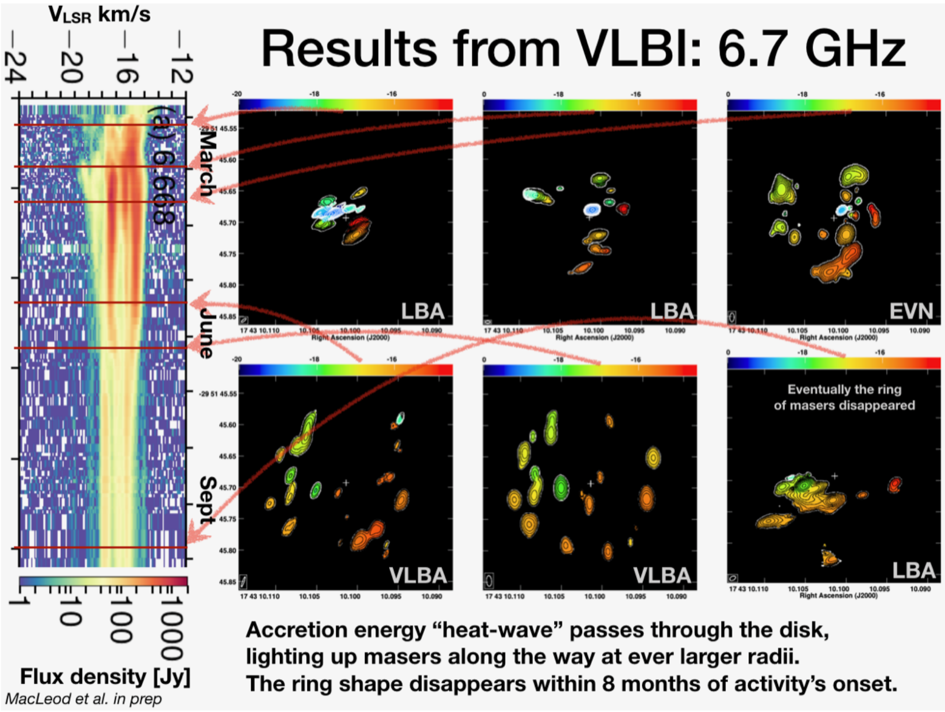


Figure 2. *Left* Evolution of the maser distribution coloured by epoch. *Right* Expansion of the maser distribution as a function of time

Some updates on the ring expansion analyses:

- The ring expansion happens in two distinct phases:
- 1st phase: at least 7.3% c propagation speed
- 2nd phase: **linear**, steady 1.3% c propagation speed
- Transition occurs somewhere at 665.25 ± 28.75 AU from the protostar. This is consistent with the ~ 650 AU radius of methanol desorption in the model in Stecklum et al. (2021).
- Maser ring is last seen at 918 AU, then dissapears. Radius is consistent with the expected disk edge.
- The current hypothesis is that of radiation (sub-luminal) propagation traversing the disk surface $>$ impacting the snow line (slow to phase two) $>$ propagating more slowly until the disk edge.



The spatial changes in the G358 6.7 GHz methanol masers, during and after the flare.

Any upcoming conferences / registration dates?

Open colloquium
April 1st, 15:30 Dutch time.
Talk by James O. Chibueze:
"Astrophysical Sciences with African Instruments: Bent Jets and Double-scythe Structures Seen by MeerKAT"
Please email James or Olga for access

Next Newsletter / Telecom: 31st March 2021, 18:00 JST

Record keeping

3 M2O Publications

No.	Target	Facility	Author	Frequency (GHz)	Status	Ref	Journal
1	W49N	Sm, Tr	Volvach+	22.2	Published	(1)	MNRAS_L
2	W49N	Sm, Tr, Mc, Ef	Volvach+	22.2	Published	(2)	A&A
3	W49N	Sm, Tr, Mc, Ef, Kvazar	Volvach+	22.2	Published	(3)	Ast.Rep.
4	W49N	Sm	Volvach+	22.2	Published	(4)	MNRAS
5	G25	VLA	Bayandina+	6.7, 12.2, 22	Published	(5)	ApJ
6	G25	Sim/Hh/Tr	Volvach+	22	Published	(6)	MNRAS_L
7	G25	KVASAR	Volvach+	22	Published	(7)	Ast.Rep.
8	G25	EVN	Burns+	22	Published	(8)	MNRAS
9	G25		Aberfelds+	6.7	in prep		-
10	G25		Bayandina+	12.2, 23.1	in prep		-
11	G25		MacCleod+	6.7, 22	in prep		-
12	G358	ATCA	Breen+	mm	Published	(9)	ApJ
13	G358	ALMA-SMA	Brogan+	mm	Published	(10)	ApJL
14	G358	Hh	MacCleod+	New Methanol masers	Published	(11)	MNRAS
15	G358	LBA	Burns+	6.7	Published	(12)	Nat.Ast.
16	G358	Various VLBI	Burns+	6.7 movie	in prep		-
17	G358	Various VLBI	Burns+	Maps of rare masers	in prep		
18	G358	VLBA	Burns+	6.7 and 12.18	in prep		
19	G358	Asia-Pacific VLBI	Orosz+	7.6, 7.8	in prep.		ApJL
20	G358	VLA	Chen+	multiple lines methanol	Published	(13)	ApJL
21	G358	VLA	Chen+	New lines + Methanol	Published	(14)	Nat. Ast.
22	G358		MacCleod+	6.7 GHz monitoring	in prep		
23	G358		MacCleod+	6.2, 12.2, 20.3, 20.9	in prep		-
24	G358	VLA	Bayandina+	6.7, 12.2, 22.2	in prep		-
25	G358	SOFIA	Stecklum+	FIR	published	(15)	A&A
26	G358	Sm and Hh	Volvach+	19.9, 20.9	Published	(16)	MNRASL
27	G358	ATCA	Breen+	Rare transitions	in prep		-
28	G24.33	EVN, VLBA	Olech+	6.7, 12.2, 22.2	in prep		-
29	G24.33	Tr	Olech+	OH, Meth	in prep		-
30	G24.33	Hh	v. d. Heever+		in prep		-
31	G24.33	ALMA	Hirota+	Thermal and maser	in prep		-

References

[1] Volvach, L. N., Volvach, A. E., Larionov, M. G., MacLeod, G. C. & Wolak, P. Unusual flare activity in the extreme-velocity 81 kms1 water-maser feature in W49N. *Monthly Notices of the Royal Astronomical Society: Letters* **487**, L77–L80 (2019). URL https://doi.org/10.1093/mnrasl/slz088.

[2] Volvach, L. N. *et al.* Flaring water masers associated with W49N. A&A **628**, A89 (2019).

[3] Volvach, L. N. *et al.* An unusually powerful water-maser flare in the galactic source w49n. *Astronomy Reports* **63**, 652–665 (2019). URL https://doi.org/10.1134/S1063772919080067.

[4] Volvach, A. E., Volvach, L. N. & Larionov, M. G. Unusually powerful flare activity of the H_2O maser feature near a velocity of -60 km s^{-1} in W49N. MNRAS **496**, L147–L151 (2020).

[5] Bayandina, O. S., Burns, R. A., Kurtz, S. E., Shakhvorostova, N. N. & Val'tts, I. E. JVLA overview of the bursting H$_2$O maser source G25.65+1.05. *arXiv e-prints* arXiv:1812.11353 (2018).

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[7] Vol'vach, L. N. *et al.* A Giant Water Maser Flare in the Galactic Source IRAS 18316-0602. *Astronomy Reports* **63**, 49–65 (2019).

[8] Burns, R. A. *et al.* VLBI observations of the G25.65+1.05 water maser superburst. MNRAS **491**, 4069–4075 (2020).

[9] Breen, S. L. *et al.* Discovery of Six New Class II Methanol Maser Transitions, Including the Unambiguous Detection of Three Torsionally Excited Lines toward G 358.9310.030. ApJ **876**, L25 (2019).

[10] Brogan, C. L. *et al.* Sub-arcsecond (Sub)millimeter Imaging of the Massive Protocluster G358.93−0.03: Discovery of 14 New Methanol Maser Lines Associated with a Hot Core. ApJL **881**, L39 (2019).

[11] MacLeod, G. C. *et al.* Detection of new methanol maser transitions associated with G358.93-0.03. MNRAS **489**, 3981–3989 (2019).

[12] Burns, R. A. *et al.* A heatwave of accretion energy traced by masers in the G358-MM1 high-mass protostar. *Nature Astronomy* 10 (2020). URL https://ui.adsabs.harvard.edu/abs/2020NatAs.tmp...10B.

[13] Chen, X. *et al.* $^{13}CH_3OH$ Masers Associated With a Transient Phenomenon in a High-mass Young Stellar Object. ApJL **890**, L22 (2020). URL https://ui.adsabs.harvard.edu/abs/2020ApJ...890L..22C.

[14] Chen, X. *et al.* New maser species tracing spiral-arm accretion flows in a high-mass young stellar object. *Nature Astronomy* (2020). URL https://ui.adsabs.harvard.edu/abs/2020NatAs.tmp..144C.

[15] Stecklum, B. *et al.* Infrared observations of the flaring maser source G358.93-0.03 – SOFIA confirms an accretion burst from a massive young stellar object. *arXiv e-prints* arXiv:2101.01812 (2021). URL https://ui.adsabs.harvard.edu/abs/2021arXiv210101812S.

[16] Volvach, A. E. *et al.* Monitoring a methanol maser flare associated with the massive star-forming region G358.93-0.03. MNRAS **494**, L59–L63 (2020).

M2O follow-up data

No.	Target	Facility	Date	Frequency (GHz)	Code	PI/comment
1	G25	VLA	Oct 2017	6.7, 12.2, 22	17B-408	OB / Reduced
2	G25+W49N	EVN	Oct 2017	22	RB004	RB / Reduced
3	G25+W49N	KaVA	Oct 2017	22	K17RB01A	RB / Reduced
4	G25+W49N	VLBA	Oct 2017	22	BO058	GO / Reduced
5	G25	VERA	2007-2013	22, 16 x epochs	[archival]	K. Motogi / Processing
6	G358	VERA	31 Jan 2019	6.7	-	SY / Reduced
7	G358	VERA	3 Mar 2019	6.7	-	SY / Reduced
8	G358	VERA	1 Apr 2019	6.7	-	SY / Reduced
9	G358	VERA	3 May 2019	6.7	-	SY / Reduced
10	G358	LBA	2 Feb 2019	6.7	vc026a	RB / Reduced
11	G358	LBA	3 Feb 2019	23.1	vc026b	GO / Abandoned
12	G358	LBA	28 Feb 2019	6.7	vc026c	RB / Reduced
13	G358	EVN	13 Mar 2019	6.7, 6.18	RB005	RB / Reduced
14	G358	KVN	25 Mar 2019	22, 44, 95, 120	n19rb01a	RB / Reduced
15	G358	VLBA	19 May 2019	6.7, 12.2, 23.1	BB414	RB / QuickLook
16	G358	VLBA	7 Jun 2019	6.7, 12.2, 20.7	BB412	RB / Reduced
17	G358	LBA+E.Asia	17 May 2019	7.6, 7.8	vx028a	GO,SE / QuickLook
18	G358	LBA+AusSCOPE	28 Sep 2019	6.7	v581a	RB / Reduced
19	G358	LBA+AusSCOPE	18 Aug 2020	6.7	v581b	RB / Reduced
20	G358	SOFIA	30 April 2019	50...120 μm		BS,JE
21	G358	GROND	8 Feb 2019	NIR		HL,BS,AC
22	G358	SMA	several 2019	mm		THunter,CB
23	G358	ALMA	several 2019	Bands 5,6,7		CB
24	G358	VLA	2019	GHz	-	OB
25	G358	VLA	2019	GHz	-	OB
26	G358	VLA	2019	HNCO	-	XC,AS
27	G24	LBA	8 Sep 2019	6.7	vx026d	RB,MO / Correlated
28	G24	LBA	13 Sep 2019	6.7	s002a	RB,MO / Correlated
29	G24	LBA	28 Sep 2019	6.7	v581a	RB,MO / Correlated
30	G24	EVN	22 Sep 2019	22	RB006A	RB,MO / QuickLook
31	G24	EVN+Merlin	7 Oct 2019	6.7	RB006B	RB,MO / QuickLook
32	G24	EVN+Merlin	17 Nov 2019	1.667	RB007	RB,MO / correlated
33	G24	VLBA	27 Sep 2019	6.7, 12.2, 22	BB416A	RB,MO / QuickLook
34	G24	VLBA	27 Oct 2019	6.7, 12.2, 22	BB416B	RB,MO / correlated
35	G24	VLBA	02 Dec 2019	6.7, 12.2, 22	BB416C	RB,MO / correlated
36	G24	ALMA	26 Sep 2019	Band6	-	THirota / QuickLook
37	G24	SOFIA	25 Oct 2019	FIR		BS,JE
38	G24	ATCA	26 Nov 2019	K-band	C3321	GO,SB
39	G24	ATCA	27 Nov 2019	C-band	C3321	GO,SB
40	NGC2071, Ori-S6	KaVA	13 Mar 2020	22/44/95/130	a20d3a	RB / QuickLook
41	NGC2071, Ori-S6	KaVA	16 Apr 2020	22/44/95/130	a20d3b	RB / QuickLook
42	NGC2071, Ori-S6	KaVA	11 May 2020	22/44/95/130	a20d3c	RB / Correlated
43	G85	VLBA	24/Apr/2020	L/C/Ku/K	BB421B	RB / QuickLook
44	G85	VLBA	22/May/2020	L/C/Ku/K	BB421A	RB / QuickLook
45	G85	VLBA	22/June/2020	L/C/Ku/K	BB421C	RB / correlated
46	G359.617-0.251	LBA	18/Aug/2020	6.7	V581B	RB / Observed
47	G359.617-0.251	VLBA	21/Aug/2020	6.7 / 12.2 / 22	BB418A	RB / Correlated
48	G359.617-0.251	ATCA	25-26/July/2020	6-10 GHz	C3321	GO / Processing
49	G034.196-0.592	VLA	19/NOV/2020	C	VLA/20B-441	DL / Processing
50	G034.196-0.592	VLA	29/NOV/2020	K	VLA/20B-441	DL / Processing
51	G034.196-0.592	KaVA	12/DEC/2020	K(QWD)	a20d4a	RB / Quick Look
52	G034.196-0.592	KaVA	23/JAN/2021	K(QWD)	a21d1a	RB / Correlating
53	G034.196-0.592	KaVA	18/FEB/2021	K(QWD)	a21d1b	RB / Observed
54	G35.200.74	KaVA	23/JAN/2021	K(QWD)	a21d1a	RB / Correlating
55	G35.200.74	KaVA	18/FEB/2021	K(QWD)	a21d1b	RB / Observed

Reminders:

All G25.65+0.15 papers should include a member from the Volvach et al. in the author list and an acknowledgement of their funding.
All G358 papers should include a member from the Ibaraki team in the author list and an acknowledgement of their funding.
All G24.33 papers should include a member from the Torun team in the author list and an acknowledgement of their funding.
All Orion-S6 papers should include a member from the Ibaraki team in the author list and an acknowledgement of their funding.
All NGC2071 papers should include a member from the VERA / Sunada team in the author list and an acknowledgement of their funding.
All G53.22-0.08 papers should include a member from the VERA / Sunada team in the author list and an acknowledgement of their funding.
All G85 papers should include a member from the Ibaraki team in the author list and an acknowledgement of their funding.
All G359 papers should include a member from the Ibaraki team in the author list and an acknowledgement of their funding.
All G034.196-0.592 papers should include a member from the Ladeyschikov et al. in the author list and an acknowledgement of their funding.
All G35.200.74 papers should include a member from the Volvach et al. in the author list and an acknowledgement of their funding.