M2O Newsletter, No. 15

The main news items this month:

1. New M2O activity at observsatories:
- **Warkworth 32m telescope** in New Zealand join monitoring efforts; cross-calibrated via comparisons to Hartebeesthoek measurements. New members Tim Natusch, Stuart Weston and Sergei Gulyaev will be introduced in the forthcoming telecom on the 30th of September.
- **Irbene single 400m baseline interferometer** have successfully demonstrated fringes and reliable flux calibration (see report).
- **Kuntunse radio telescope in Ghana** a converted 32m telecom dish will join us, and possibly the
- **Goonhilly** observatory in the UK. Melvin Hoare and Proven Adziri are the relevant contacts.
All individuals mentioned above are added to the website, mailing list ans SamePage platform.

2. Admin: Website updates: Station map, News, Member and Publication lists (see reports)

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1 Activity since the previous Newsletter

- **SamePage:** +5 (Tim, Stuart, Sergey, Proven, Melvin), total 69 members
- **Papers accepted:** +0; Total: 15
- **Papers under review:** +0

- **Updates on papers in prep:**
  - Bayandina et al., VLA masers in G358. Images circulated during the prev. telecom.
  - Burns et al., 6.7 GHz VLBI movie in G358. Images circulated during the prev. telecom.
  - Burns et al., VLBI maps of rare maser lines in G358. Images circulated during the prev. telecom.
  - Orosz et al., 7.6 and 7.8 GHz methanol masers in G358, aiming for ApJL submission in August.
  - Hirota et al., ALMA follow-up observations of G24.33+0.14 in pre- and post- maser flare phases.
  - Olech et al., VLBI images of G24.33 during its maser flare.
  - Stecklum et al., SOFIA and radiative transfer analyses of the G358 accretion burst.
  - Gray et al., Two additions to the maser flare series: compression and overlap.

- **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	150	Yonekura	Ib, Hh,	decreasing
Orion S6	6.7	3.1	9	4	Yonekura	Ib, Tr, Sz, Hh	stable
G85.411+0.002	6.7	12	95	110	Yonekura	Ib, Ef, Sz, Tr, Hh, Ky, Vs	rising
G33.641-0.228	6.7	-	236	236	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	8	Torun	Hh, Ib, Vs	decreasing
G25.65+1.05	22	-	60k	2150	Sz	Hh, Sz	post-burst

(Ib = Ibaraki) (Tr = Torun) (Sz = Simeiz) (Hh = HartRAO) (Ef = Effelsberg) (Ky = KVN Yonsei) (Vs = Ventspil) (Vr = VERA stations) (Mc = Medicina)

- **Follow-up observations conducted this month (see Record Keeping for details):**
  LBA trigger (V581B) of the 6.7 GHz methanol maser in G359
  VLBA trigger (BB418A) of the (methanol) 6.7, 12.2 and (water) 22 GHz masers in G359
- **New observing proposals:** None
- **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	01/JUN/20
KaVA	EAVN20B-183	7.2 / 10.0 (10 is best)	2 x 3 x 8 = 48	48	01/Sep/20 - 01/Feb/21	15/JUN/20
LBA	V581	4.0 / 5.0 (5 is best)	96	88	01/OCT/19 - 01/OCT/20	16/JUN/20
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	-

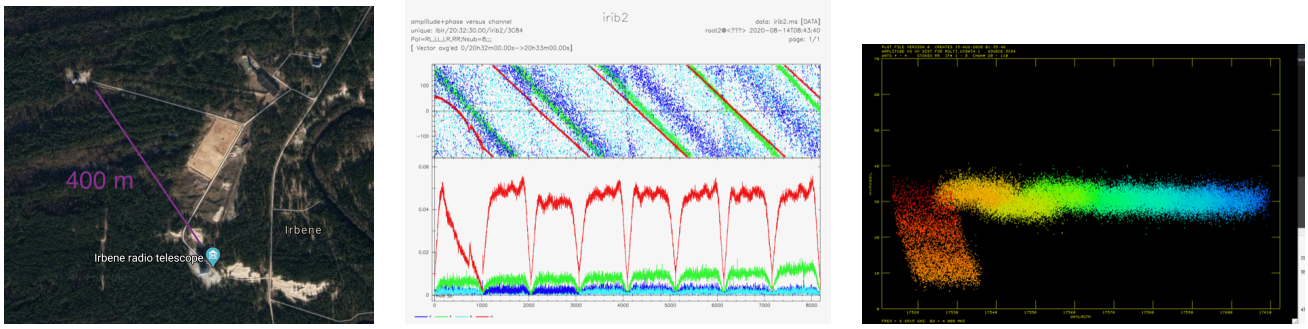
Next Newsletter / Telecom: 30th Sep 2020, 18:00 JST

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.

Introduction of the Irbene 400m single baseline interferometer:
Artis Aberfelds, Janis Steinbergs, Ivars Smelds

Collaborators:
Ross A. Burns, James O. Chibueze, Gordon MacLeod, Kenta Fujisawa, Kazuhito Motogi, Sawada-Satoh.



Left: Google map image of the Irbene single baseline interferometer. Middle: fringes for 3C84 using the SFXC correlator. Right: Calibrated Flux vs baseline-length plot of 3C84, colours indicate BBCs

As suggested in the previous M2O telecom a single baseline interferometer can make important contributions to the M2O group's research. Kenta Fujisawa did point out that this kind of interferometer has one strong advantage over single dish telescope – the ability to reach very closely to theoretical noise level for continuum source. Therefore, it becomes practically feasible to detect signal from ultra-compact HII region associated with methanol 6.7 GHz maser hosting high – mass protostars. In the case of accretion burst sources, radio continuum monitoring could reveal the temporal evolution of HII region formation and / or jet formation following an accretion burst. Both of which are key ingredients to a complete theory of high mass star formation. However, surveying and monitoring such emission with full interferometers is not cost effective in terms of telescope time. While a single baseline cannot form images it can sensitively monitor source brightness exclusively from emission on arcsecond scales; resolving out the background sky noise.
Since the past telecom we have conducted 3 test experiments using the system, a summarry is given below:

- The interferometer is a 400m single baseline system which comprises two C-band telescopes, of 32 and 16 meters (RT-32 and RT-16), see Figure 1 left.
- The system uses the SFXC correlator and can output data to FITS format for post processing. It can handle 16 x BBCs, usually comprising 8 x 4 MHz channels for each of LCP and RCP polarisations, see Figure 1, middle.
- Theoretical sensitivity calculations estimate that the RT-32 – RT-16 baseline can achieve a 0.02 Jy r.m.s. noise for a 120 sec integration in a single 4 MHz BBC.
- Combining 8 BBCs in post processing deepens the theoretical sensitivity to 7.4 mJy. Further, combining the RCP and LCP and all BBCs will deepen the sensitivity to a maximum of 5.3 mJy.
- The Ir – Ib single baseline interferometer can accurately measure continuum source absolute flux with use of ANTAB files produced in VLBI type observations. Our tests of 3C345 and 3C84 (Figure 1, right) produced flux values which match those in the literature, within typical errors.
- The Ir - Ib system is used during down time of the RT-32 station which regularly takes part in EVN and local scientific projects. The typical downtime available for the single baseline operation mode is around 10 hours per month.

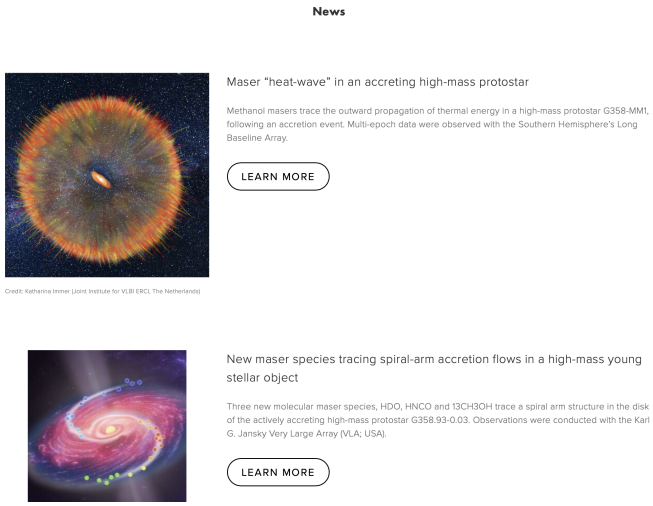
Our initial tests have demonstrated the ability to reach the theoretical sensitivity for a single BBC, which allows us to extrapolate to an expected full sensitivity of 5.3 mJy when the system is fully operational. Howerver there remain issues in the setup of the system such that it is not currently possible to integrate all BBCs and polarisations (See Figures 1, middle and right). Further tests and diagnostics of these issues are underway and solutions are being tested at present.

A ParcelTongue pipeline will be developed to automate achievement of the theoretical noise sensitivity in post processing in a systematic way. Science projects and sources lists are now under consideration.

Website updates: Ross Burns

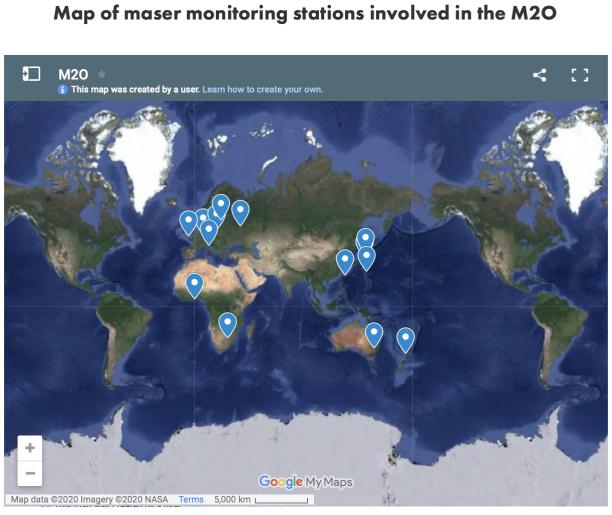
Some small additions to our website MaserMonitoring.org

In addition to adding the names of new members (please make sure your name is there just in case I've missed it) the News section has been updated with Xi Chen's latest Nature Astronomy paper. If you have some news piece that you'd like added please just let me know.



Screenshot of the News section of the M2O website

Furthermore, as requested previously. I've put together a map of M2O collaborating observatories. Its basic for now but thanks to using embedded google maps the website is updated whenever the peronal google map is updated. I've added Kuntunse, Warkworth and Goonhilly. We can add more features over time, as requested.



Screenshot of the new map section of the M2O website. Selecting a station brings up their contact details and website

Forthcoming planned additions will be a sky map of M2O published sources which link to relevant publications. More details on observatories too. If you have any ideas of additional features do let me know.

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	in prep		A&A_L
26	G358	Sm and Hh	Volvach+	19.9, 20.9	Published	(15)	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		-

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[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. http://oup.prod.sis.lan/mnrasl/article-pdf/487/1/L77/28864243/slz088.pdf.

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

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[11] MacLeod, G. C. *et al.* Detection of new methanol maser transitions associated with G358.93-0.03. MNRAS **489**, 3981–3989 (2019). 1910.00685.

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[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).

[14] Chen, X. *et al.* New maser species tracing spiral-arm accretion flows in a high-mass young stellar object. *Nature Astronomy* (2020).

[15] 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	SOFIA	30 April 2019	50...120 μm		BS,JE
20	G358	GROND	8 Feb 2019	NIR		HL,BS,AC
21	G358	SMA	several 2019	mm		THunter,CB
22	G358	ALMA	several 2019	Bands 5,6,7		CB
23	G358	VLA	2019	GHz	-	OB
24	G358	VLA	2019	GHz	-	OB
25	G358	VLA	2019	HNCO	-	XC,AS
26	G24	LBA	8 Sep 2019	6.7	vx026d	RB,MO / Correlated
27	G24	LBA	13 Sep 2019	6.7	s002a	RB,MO / Correlated
28	G24	LBA	28 Sep 2019	6.7	v581a	RB,MO / Correlated
29	G24	EVN	22 Sep 2019	22	RB006A	RB,MO / QuickLook
30	G24	EVN+Merlin	7 Oct 2019	6.7	RB006B	RB,MO / QuickLook
31	G24	EVN+Merlin	17 Nov 2019	1.667	RB007	RB,MO / correlated
32	G24	VLBA	27 Sep 2019	6.7, 12.2, 22	BB416A	RB,MO / QuickLook
33	G24	VLBA	27 Oct 2019	6.7, 12.2, 22	BB416B	RB,MO / correlated
34	G24	VLBA	02 Dec 2019	6.7, 12.2, 22	BB416C	RB,MO / correlated
35	G24	ALMA	26 Sep 2019	Band6	-	THirota / QuickLook
36	G24	SOFIA	25 Oct 2019	FIR		BS,JE
37	G24	ATCA	26 Nov 2019	K-band	C3321	GO,SB
38	G24	ATCA	27 Nov 2019	C-band	C3321	GO,SB
39	NGC2071, Ori-S6	KaVA	13 Mar 2020	22/44/95/130	a20d3a	RB / QuickLook
40	NGC2071, Ori-S6	KaVA	16 Apr 2020	22/44/95/130	a20d3b	RB / QuickLook
41	NGC2071, Ori-S6	KaVA	11 May 2020	22/44/95/130	a20d3c	RB / Correlated
42	G85	VLBA	24/Apr/2020	L/C/Ku/K	BB421B	RB / QuickLook
43	G85	VLBA	22/May/2020	L/C/Ku/K	BB421A	RB / QuickLook
44	G85	VLBA	22/June/2020	L/C/Ku/K	BB421C	RB / correlated
45	G359.617-0.251	LBA	18?Aug/2020	6.7	V581A	RB / Observed
46	G359.617-0.251	VLBA	21/Aug/2020	6.7 / 12.2 / 22	BB418A	RB / Correlated
47	G359.617-0.251	ATCA	25-26/July/2020	6-10 GHz	C3321	GO / Processing

Reminder:

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 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.