# M2O Newsletter, No. 25

**Irbene single baseline interferometer update:** Automatic pipeline improved. Still would benefit from comparison to independent results and/or standard flux calibration sources (See Reports).

**Full 6.7 GHz VLBI result of G358:** Pre-submission enquiry was sent to Nature who passed it to Nature Astronomy where it was invited as a full paper submission. Discussion and drafting in progress.

**EVN mini symposium:** Video library of talks and poster pres. available at: Link to YouTube

**VLBA proposal (K. Sugiyama):** to measure the trigonometric parallax of G358-MM1 using 6.7 GHz methanol maser.

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## 1 Activity since the previous Telecom

- **SamePage:** +0: total 77 members.
- **Papers accepted:** +0; Total: 16
- **Papers in revision:**
  A.E. Volvach, L.N. Volvach, M.G. Larionov, "Composite powerful short flare of water maser in young binary system IRAS 16293-2422"
  MacCarthy et al., ATCA observations of the G24 and G359 methanol maser flare events. A.E. Volvach et al., "The powerful flare event of a water maser in the young protostellar system IRAS 16293-2422"
- **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 Telecom13 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- flare phases. (see Telecom 20 Report)
  - Kobak et al., VLBI images and SD monitoring of G24.33 during the maser flare(s).
  - 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 | 90 | Yonekura | Ib, Hh, | decreasing |
| Orion S6 | 6.7 | 3.1 | 9 | 2 | Yonekura | Ib, Tr, Sz, Hh | variable |
| G85.411+0.002 | 6.7 | 12 | 95 | 80 | Yonekura | Ib, Ef, Sz, Tr, Hh, Ky, Vs | decreasing |
| G33.641-0.228 | 6.7 | - | 236 | 60 | Bringfried | Hh, Ib, Vs | eruptive |
| IRAS 16293-2422 | 22 | - | 30k | - | Sunada, Mc | Vr, Mc, Hh, Sz, Ib, Mc | - |
| 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 | 15 | Yonekura | Hh, Ib | decreasing |
| G24.33+0.14 | 6.7 | - | 800 | 5 | Torun | Hh, Ib, Vs, Mc | decreasing |
| G25.65+1.05 | 22 | - | 60k | 2150 | Volvach | Hh, Sz, Mc | post-burst |
| G034.196-0.592 | 22 | - | 120 | 120 | Ladeyschikov | Sz, Oa, Hh, Mc | ? |
| 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:**
  VLBA: Trigonometric parallax measurement of G358.93-00.03 (PI: K Sugiyama)
- **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/22 * |
| KaVA | EAVN21A-213 | 7.6 / 10.0 (10 is best) | 2 x 1 x 8 = 16 | 16 | 16/JAN/21 - 15/JAN/22 | 15/NOV/21 # |
| EAVN | EAVN21A-214 | 8.3 / 10.0 (10 is best) | 1 x 2 x 8 = 16 | 16 | 16/JAN/21 - 15/JAN/22 | 15/NOV/21 # |
| LBA | V581 | 4.1 / 5.0 (5 is best) | 96 | 88 | 01/OCT/20 - 01/OCT/21 | 16/JUN/22 * |
| VLBA | BB418 | 0.59 / 10.0 (0 is best) | 48 | 48 | 01/AUG/20 - 01/AUG/21 | 01/FEB/22 # |
| VLA | VLA/21A-035 | [score] | 12 | 12 | [dates] | - |
| SOFIA | 90053 | [score] | 3.46 | 3.46 | [dates] | - |
| ATCA | C3321 | [score] | 50 | 50 | [dates] | - |
| Subaru | S20B0051N | [score] | 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 | - |

(*/#) New proposals already (submitted/accepted) for the following observing semester

- **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.

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## Irbene single baseline interferometer update: R Burns and Irbene members

Some additional features and versitility have been added to the pipeline and initial monitoring results are coming available, shown below for two sources.

**Main points:**

- Maser and continuum emission in G85 (left figure) show similar flux trends suggestive of residual gain calibration offsets. These can be resolved by setting a stable maser feature as the flux normaliser and would bring continuum calibration errors down significantly. Another possiblity is that phase de-coherence is leading to flux losses at integration, which varies per-experiment. This needs to be investigated.
- Continuum emission in CEPA closely follow trends seen in 3C345, suggesting that there are per-experiment gain offsets effecting all sources. This could be solved by setting 3C345 as a flux calibrator. The similarity in flux trends suggest that the phase calibration is fine.
- Interestingly, both G85 and CEPA show systematic gain offsets, but those offsets are different per source. This could be due to elevation differences (imperfect gain curves), or possibly that G85 is experiencing phase de-coherence while CEPA is not.

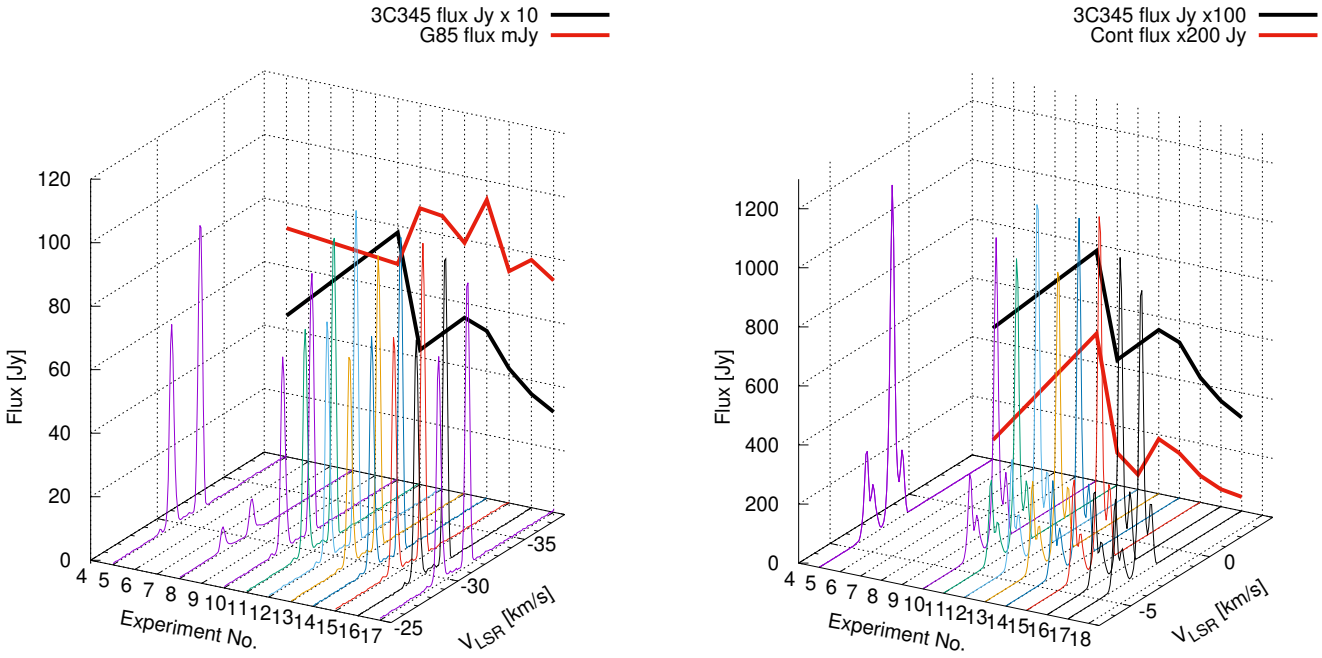


*Figure 1: Flux vs time for maser and continuum emission in G85 and CEPA, with 3C345 flux vs time also included for comparison*

**Main points:**

- An expanded source list is now being observed and processed in order to check detectability and evaluate sensitivity of the instrument.
- A grant application has been initiated to get further support for development.

## Upcoming conferences / registration dates?

**IAU symposium 362: THE PREDICTIVE POWER OF COMPUTATIONAL ASTROPHYSICS, November 8-12**
Abstract and registration deadline: September 15th. A. Sobolev will give a talk. Event details can be found here.

**Baltic Applied Astroinformatics and Space data Processing" (BAASP), Sep 23-24** The specific themes are: astronomy, radio astronomy, space technologies, remote sensing. Abstract and registration deadline: July 31st. Event details can be found here.

## Next Newsletter / Telecom: 30th July 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).

[6] Volvach, L. N. *et al.* Powerful bursts of water masers towards G25.65+1.05. MNRAS **482**, L90–L92 (2019).

[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 / On hold |
| 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 / Published |
| 11 | G358 | LBA | 3 Feb 2019 | 23.1 | vc026b | GO / Abandoned |
| 12 | G358 | LBA | 28 Feb 2019 | 6.7 | vc026c | RB / Published |
| 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 / Reduced |
| 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 / Reduced |
| 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 $\mu m$ | | BS,JE / Published |
| 21 | G358 | GROND | 8 Feb 2019 | NIR | | HL,BS,AC / Published |
| 22 | G358 | SMA | several 2019 | mm | | THunter,CB / Published |
| 23 | G358 | ALMA | several 2019 | Bands 5,6,7 | | CB / Published |
| 24 | G358 | VLA | 2019 | C, Ku bands | - | OB |
| 25 | G358 | VLA | 2019 | K band | - | 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 / Reduced |
| 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 / Quick Look |
| 43 | G85.411+0.002 | VLBA | 24/Apr/2020 | L/C/Ku/K | BB421B | RB / QuickLook |
| 44 | G85.411+0.002 | VLBA | 22/May/2020 | L/C/Ku/K | BB421A | RB / QuickLook |
| 45 | G85.411+0.002 | VLBA | 22/June/2020 | L/C/Ku/K | BB421C | RB / Quick Look |
| 46 | G359.617-0.251 | LBA | 18/Aug/2020 | 6.7 | V581B | RB / Quick Look |
| 47 | G359.617-0.251 | VLBA | 21/Aug/2020 | 6.7 / 12.2 / 22 | BB418A | RB / Quick Look |
| 48 | G359.617-0.251 | ATCA | 25-26/July/2020 | 6-10 GHz | C3321 | GO / Submitted |
| 49 | G034.196-0.592 | VLA | 19/NOV/2020 | C | VLA/20B-441 | DL / Calibrated |
| 50 | G034.196-0.592 | VLA | 29/NOV/2020 | K | VLA/20B-441 | DL / Calibrated |
| 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 / Quick Look |
| 53 | G034.196-0.592 | KaVA | 18/FEB/2021 | K(QWD) | a21d1b | RB / Quick Look |
| 54 | G35.200.74 | KaVA | 23/JAN/2021 | K(QWD) | a21d1a | RB / Quick Look |
| 55 | G35.200.74 | KaVA | 18/FEB/2021 | K(QWD) | a21d1b | RB / Quick Look |

**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.