Summary of NIKA2 calibration files for the PIIC data reduction software

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Warning:

The latest released DAFs cover all science weeks from NIKA2 run 12 to 79, plus few test/commissioning weeks. Using these DAFs to reduce data taken during other NIKA2 runs *not* covered by this document, might result in an *incorrect* calibration. Such data will need to be reduced again once the dedicated DAFs will be released.

PIIC calibration files for NIKA2

In order to process NIKA2 data, PIIC needs a set of calibration files, that describe the properties of the kinetic inductance detectors (KIDs) array and of the atmosphere: geometry, resonance frequencies, cross-talking, response to incoming light (i.e. flux calibration), atmospheric opacity and relation of skyload to line-of-sight extinction correction. These are called "*data associated files*" (DAFs) and can be retrieved from the GILDAS download pages.

At each new release of PIIC, the DAFs database is included in the PIIC package.

After each observing pool, the PIIC support team processes calibration data and produces new calibration files. The DAFs database is thus updated and a new version is available online, in a separate tar-ball, independent of the PIIC package. Therefore, when browsing the PIIC GILDAS pages for updates, always check for new PIIC *and* DAFs tar-balls.

DAFs content

The PIIC DAFs consist of six different main types of files. In alphabetical order:

- calibration files (CAL), defining the response of KIDs for flux calibration after flat fielding;
- deleted receiver pixels (DRP) files, listing those KIDs that are known to cross-talk;
- frequency files (NKFR), listing the natural resonance frequencies of all KIDs, for different *sweeps*[1];
- Files defining the relation between the line-of-sight extinction correction and skyload (NKSLEX) for the given NIKA2 observing week(s).
- receiver pixels parameters (RPP), listing the main parameters defining the KIDs for each sweep;
- atmospheric conditions over all observing runs (TAU files), i.e. the values of the zenith opacity τ, as produced by the observatory's tau-meter and converted to the 2 mm and 1 mm NIKA2 bands.

DAFs production

The PIIC DAFs are constructed starting from calibration scans taken during the NIKA2 observing sessions. This operation is done by the PIIC support team and is completely transparent to the users.

KIDs resonance frequencies (NKFR) are a intrinsic characteristic of the detectors and are defined at each new

1 a sweep is practically a re-definition of KIDs resonance frequencies, performed regularly for each new season.

sweep. They are thus basically an input information, that does not need to be computed a posteriori by the PIIC team. They're used to check if the DAFs are valid for the given observing pool.

The receiver pixels parameters (RPP) files define the major parameters required for data processing: the position of each KID in the field of view of NIKA2, the forward and main beam "flat-fields", flags, etc. Each KID is identified in resonance-frequency space, therefore its spatial position is not known a priori. Beam maps are used to derive the KIDs positions in the FoV. The order of KIDs in resonance frequency is re-shuffled at each new *sweep*, therefore new RPPs (as DRPs) are needed at least at each new sweep.

The list of DRPs is built and regularly updated via visual checks of the cross-talking KIDs, based on beam-maps. A new list is defined for each new sweep. However, as the resonance frequencies drift with aging of the KIDs, more than one list per sweep might be necessary through time.The DRPs list only the strongest cross-talks, i.e. above 5% of flux "transfer". This is a "static" list of KIDs to be excluded. During the data processing, additional selection criteria apply and more KIDs are rejected based – for example – on tuning angle, r.m.s. along the timeline, stability, etc.; this is a "dynamic" list of discarded KIDs, that may differ for each scan.

Tau-meter files are provided by the observatory after each NIKA2 observing run. They are used to produce the TAU files for the 2 mm and 1 mm NIKA2 bands. The tau-meter observes the sky and derived its opacity in a fixed direction, roughly oriented to the West (when you visit the Pico Veleta observatory, ask the operator to show you where the tau-meter is located).

The flux calibration files (CAL) simply contain a constant that translates the instrumental units into physical units. They are produced starting from observations of standard calibrators (primary/secondary), such as planets or other well known sources. Dedicated small-maps, as well as pointing and focus scans are used to derive and verify the flux calibration factors. The reference absolute fluxes of the primary calibrators (i.e. Planets) are taken from the models implemented in GILDAS/ASTRO. In the *current implementation* (as of 2025/05/30), the reference 100 GHz brightness temperatures of Venus, Uranus and Neptune are 350, 132 and 125 K, respectively, with a 5% accuracy. A spectral index of -0.35 is used to derive their intrinsic fluxes at the NIKA2 frequencies (260 and 150 GHz).

Finally, the latest addition to the DAFs as of December 2022, describes the correlation of extinction correction to sky load (NKSLEX). Because the average sky load of a scan depends on atmospheric conditions (temperature, opacity, turbulence, etc.), the sky load of the given scan can be used to refine the extinction correction along the actual *line-of-sight* and thus the flux calibration of that scan. The observed calibrators are used to define a function between the extinguished flux of the source and sky load: $log(F_{ext})=a\times SkyLoad+b$. This is then applied when calibrating the flux scale of each scan. Note that the tau-meter sky opacity is still needed to define the absolute flux calibration. This function is strongly dependent on the NIKA2 *sweep*, on seasonal atmospheric variations, and even on variabilities of weekly time scales. Therefore NKSLEX are redefined for each NIKA2 run.

Figure 1 shows how well the flux of the calibrator objects is retrieved in the process of flux calibration (using the main beam, MB, flux measurement) for all NIKA2 runs so far. Figure 2 focuses on all individual NIKA2 runs and displays well the scatter of the calibration. The atmospheric opacity is overplotted (blue line, pink points, right-hand y-axis). Figure 3 compares the retrieved flux fraction of the calibrators to the elevation at which they were observed. Note that the calibration of all NIKA2 runs was computed after applying the telescope's gain-elevation correction for the MB, as determined by RZ using the data taken during the best weather conditions. Figure 4 depicts the principles of the NKSLEX DAFs, showing how the above mentioned log-linear fit is performed and applied to the data. Figure 5 compares the result of calibration obtained using only the tau-meter sky opacity and the line-of-sight opacity for the example NIKA2 run 61. Figure 6 shows the difference of the calibration accuracy between day and night.

Notes about the quality of calibration

Calibration scans (beam maps, flux calibrators maps, pointing, focus) are processed after each observing run. Different runs and scans are observed under different conditions (e.g. atmospheric and instrumental), hence for some pools the calibration scans are more accurate than for others.

Several factors can contribute to the quality of DAFs (RPPs, CAL, ...):

- The fine position of KIDs in the FoV depends on focus. The focal surface is not flat, but at 1 mm has variations of up to ~0.7 mm from the center to the edges of the Array. Because of this, the effective beam positions may differ from the ones given in the RPPs. The discrepancy might be even >FWHM/2, especially in the upper-left part of the FoV.
- Gain-elevation dependence (see J. Peñalver reports[2] of 2012 for an explanation), due to homologous deformations generated by gravity. This is one component of astigmatism depending on telescope Elevation. The structural distortions are minimal for an Elevation of ~50 deg and operate in different perpendicular directions at lower/higher Elevations. When off-focus, the astigmatism worsens.
- Non-homologous deformations – now larger than in the past – visible as an effect of the temperature of the telescope, whose structure and surface deform under the irradiation of the sun.
- Different observing methods or strategies and different map sizes also affect the calibration: because of the changes of focus across the FoV, maps of different sizes (e.g. pointings *vs.* small maps on calibrators), will not give the same results for the same value of atmospheric opacity, as different KIDs "see" the source.
- Because of the above-mentioned reasons and because of sky conditions, observations taken at different times of the day have different quality (beam shape, flux calibration r.m.s., stability, etc.). Telescope distortions are exasperated during day time, and sky stability is poor. Table 2 includes r.m.s. values for day+night and night-only calibrator observations. In Figure 6 an example (NIKA2 run 14) is shown.
- Finally, some observing periods benefitted from better general observing conditions than others, e.g. better weather conditions and a more optimal combination of all factors listed above. Different "selection criteria for performing the observations"might have been applied in different observing pools, e.g. accepting the telescope or weather conditions, because of different team present at the telescope, or other contingency reasons.

DAFs choice

The philosophy of the PIIC team is to use the best possible DAFs for each run. Consequently, even if calibration scans are analyzed for each run and new RPP/CAL/DRP are produced, the DAFs to be used to reduce the science data of a given pool were not necessarily taken during that same pool.

Unless a new instrumental configuration comes into play (e.g. a new sweep, optics changes, hardware modifications, etc.) or a new flux calibration is needed, if the new calibration files obtained during the given pool are not better than the previous ones, we keep using the best (older) DAFs. Therefore, during the calibration analysis of each new run, the current geometry, flux calibration and cross-talking are always verified against the best DAFs valid for that instrumental setup, and only if no significant changes are present the old ones are kept.

Finally, note that TAU and NKSLEX files are naturally different for each NIKA2 run, on the contrary NKFR files are updated only when a new *sweep* is performed.

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2 http://www.iram.es/IRAMES/mainWiki/AstronomerOfDutyChecklist#Gain_elevation_correction
Note that this reports on the peak flux gain-elevation curve, but here the main beam gain-elevation correction is used.

Focus factor and other effects

The calibration analysis is performed selecting the best scans on the basis of the source profile FWHM and other factors, thus excluding defocused and poor quality scans. The results shown in Figures 1 and 2, and the values listed in Table 2 are thus based on the best scans of calibrators taken in each run. In reality, science observations are not always taken under ideal observing conditions. Here we warn about some of the possible effects that can affect the data.

During the day the telescope distorts and the beam is broadened and suffers for stronger astigmatism. Consequently, the flux loss at a *fixed aperture* increases and only a fraction of the total flux is recovered. This effect can be understood in focus sequences.

In Summer 2023 the 30m telescope underwent a major upgrade of the servo and control systems. After this refurbishment the sub-reflector was not perfectly aligned for a period of time (NIKA2 science run 65 and 2/3 of run 66). The calibration r.m.s. of this period of time is therefore of slightly larger than in previous periods.

Using the new NKSLEX calibration refinement, any dependences of the calibrators recovered flux *vs.* extinction correction (seen applying only the tau-meter extinction correction) are naturally corrected. In fact the proper atmospheric opacity along the line-of-sight of the given scan is now computed and applied, instead of the mere estimate obtainned in the azimuth direction where the tau-meter observes.

In March and June 2025, NIKA2 underwent a major upgrade, including the change of the 1.2 mm arrays (Ar1 and Ar3), of some cold lenses, of some IR-blocking filters and of the dichroic. The new 1.2 mm arrays are in use since the NIKA2 run 72. After this upgrade, the focus difference between the three arrays increased to ~0.65 mm between Ar2 and Ar1, ~0.3 mm between Ar1 and Ar3, and therefore up to ~1.0 mm between Ar2 and Ar3. Starting with the NIKA2 run 75, the chosen focus is the one of Ar1 as best compromise. As a consequence, the CAL (main beam) factors have changed in the NIKA2 run 72 [because of the new Ar1 and Ar3 arrays] and again in the NIKA2 run 75 [mainly because the relative fraction of flux in the main beam and error beam has changed].

Availability table

Here we summarize, for each NIKA2 science pool, and *only* for science pools (plus few extras), some basic information about the NIKA2 instrumental setup and the content of PIIC DAFs. For the latter, the number of used beam maps and flux calibrator scans are specified, as well as whether DAFs are available and in which run the adopted RPP files and the flux calibration factors (CAL) were first defined.

Table 1: basic information about NIKA2 science pools and the related DAFs

Run* Nika2/Cryo	**Dates**	**DAQ version**	**Sweep**	**# Beam maps**	**# Flux Calib.****	**Calib.*** processed**	**DAFs available**	**RPP version**	**Flux calib factor**
12/25	2017/10/24 2017/10/31	1	Ar2 2017/10 Ar1&3 2017/10	17	Ar2 145 Ar1 106 Ar3 103	y	y	Ar2 Run 12 Ar1 Run 12 Ar3 Run 12	Ar2 Run 12 Ar1 Run 12 Ar3 Run 12
14/27	2018/01/16 2018/01/23	1	Ar2 2017/10 Ar1&3 2017/10	15	Ar2 100 Ar1 96 Ar3 81	y	y	Ar2 Run 12 Ar1 Run 12 Ar3 Run 12	Ar2 Run 12 Ar1 Run 12 Ar3 Run 12
15/28	2018/02/13 2018/02/20	1	Ar2 2017/10 Ar1&3 2017/10	8	Ar2 75 Ar1 71 Ar3 76	y	y	Ar2 Run 12 Ar1 Run 12 Ar3 Run 12	Ar2 Run 12 Ar1 Run 12 Ar3 Run 12
17/30	2018/03/13 2018/03/20	1	Ar2 2017/10 Ar1&3 2017/10	Lost because of bad weather					
18/31	2018/05/22 2018/05/29	1	Ar2 2017/10 Ar1&3 2017/10	4	Ar2 21 Ar1 19 Ar3 23	y	y	Ar2 Run 12 Ar1 Run 12 Ar3 Run 12	Ar2 Run 12 Ar1 Run 12 Ar3 Run 12
22/36	2018/10/02 2018/10/09	2	Ar2 2018/10 Ar1&3 2018/10	Lost because of DAQ v2 malfunctioning					
23/37	2018/10/30 2018/11/06	1	Ar2 2018/10 Ar1&3 2018/10	9	Ar2 54 Ar1 25 Ar3 22	y	y	Ar2 Run 21 Ar1 Run 21 Ar3 Run 21	Ar2 Run 12 Ar1 Run 23 Ar3 Run 12
24/38	2018/11/20 2018/11/27	1	Ar2 2018/10 Ar1&3 2018/10	5	Ar2 41 Ar1 34 Ar3 34	y	y	Ar2 Run 21 Ar1 Run 21 Ar3 Run 21	Ar2 Run 12 Ar1 Run 23 Ar3 Run 12
26/40	2019/01/15 2019/01/22	1 (+3)	Ar2 2018/10 Ar1&3 2018/10	10	Ar2 31 Ar1 29 Ar3 28	y	y	Ar2 Run 21 Ar1 Run 21 Ar3 Run 21	Ar2 Run 12 Ar1 Run 23 Ar3 Run 12
27/41	2019/01/29 2019/02/05	1	Ar2 2018/10 Ar1&3 2018/10	2	Ar2 58 Ar1 45 Ar3 45	y	y	Ar2 Run 21 Ar1 Run 21 Ar3 Run 21	Ar2 Run 12 Ar1 Run 23 Ar3 Run 12
28/42	2019/02/12 2019/02/19	1	Ar2 2018/10 Ar1&3 2018/10	2	Ar2 26 Ar1 28 Ar3 26	y	y	Ar2 Run 21 Ar1 Run 21 Ar3 Run 21	Ar2 Run 12 Ar1 Run 23 Ar3 Run 12
29/43	2019/03/05 2019/03/12	1	Ar2 2018/10 Ar1&3 2018/10	7	Ar2 54 Ar1 25 Ar3 22	y	y	Ar2 Run 21 Ar1 Run 21 Ar3 Run 21	Ar2 Run 12 Ar1 Run 23 Ar3 Run 12
30/44	2019/03/19 2019/03/26	1+3	Ar2 2018/10 Ar1&3 2018/10 Ar1&3 2019/03	9	Ar2 41 Ar1 22 Ar3 21	y	y	Ar2 Run 21 Ar1 R21/34 Ar3 R21/34	Ar2 Run 12 Ar1 Run 23 Ar3 Run 12
34/48	2019/10/08 2019/10/14	1	Ar2 2019/09 Ar1&3 2019/03	14	Ar2 138 Ar1 110 Ar3 107	y	y	Ar2 Run 34 Ar1 Run 34 Ar3 Run 34	Ar2 Run 34 Ar1 Run 34 Ar3 Run 34
35/48b	2019/10/15 2019/10/22	1	Ar2 2019/09 Ar1&3 2019/03						

Run* Nika2/Cryo	Dates	DAQ version	Sweep	# Beam maps	# Flux Calib.**	Calib.*** processed	DAFs available	RPP version	Flux calib factor
36/49	2019/10/29 2019/11/04	1	Ar2 2019/09 Ar1&3 2019/03	9	Ar2 73 Ar1 39 Ar3 47	y	y	Ar2 Run 34 Ar1 Run 34 Ar3 Run 34	Ar2 Run 34 Ar1 Run 34 Ar3 Run 34
37/49b	2019/11/05 2019/11/12	1	Ar2 2019/09 Ar1&3 2019/03						
38/50	2019/12/10 2019/12/17	1	Ar2 2019/09 Ar1&3 2019/03	3	Ar2 52 Ar1 41 Ar3 32	y	y	Ar2 Run 34 Ar1 Run 34 Ar3 Run 34	Ar2 Run 34 Ar1 Run 34 Ar3 Run 34
39/51	2020/01/14 2020/01/21	1	Ar2 2019/09 Ar1&3 2020/01	4	Ar2 70 Ar1 60 Ar3 64	y	y	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
40/52	2020/01/28 2020/02/04	1	Ar2 2019/09 Ar1&3 2020/01	9	Ar2 66 Ar1 60 Ar3 56	y	y	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
41/53	2020/02/11 2020/02/18	3	Ar2 2019/09 Ar1&3 2020/01	7	Ar2 146 Ar1 119 Ar3 123	y	y	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
43/55	2020/03/10 2020/03/17	3	Ar2 2019/09 Ar1&3 2020/01	5	Ar2 116 Ar1 76 Ar3 82	y	y	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
45/57	2020/10/20 2020/11/03	3	Ar2 2020/10 Ar1&3 2020/10	10	Ar2 100 Ar1 84 Ar3 80	y	y	Ar2 Run 45+47 Ar1 Run 45+47 Ar3 Run 45+47	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
47/59	2020/11/17 2020/11/24	3	Ar2 2020/10 Ar1&3 2020/10	4	Ar2 70 Ar1 56 Ar3 58	y	y	Ar2 Run 45+47 Ar1 Run 45+47 Ar3 Run 45+47	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
48/60	2020/12/08 2020/12/15	3	Ar2 2020/10 Ar1&3 2020/10	3	Ar2 21 Ar1 4 Ar3 5	y	y	Ar2 Run 45+47 Ar1 Run 45+47 Ar3 Run 45+47	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
49/61	2021/01/12 2021/01/26	3	Ar2 2020/10 Ar1&3 2020/10	5	Ar2 96 Ar1 77 Ar3 75	y	y	Ar2 Run 45+47 Ar1 Run 45+47 Ar3 Run 45+47	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
50/62	2021/02/09 2021/02/23	3	Ar2 2020/10 Ar1&3 2020/10	11	Ar2 49 Ar1 45 Ar3 44	y	y	Ar2 Run 45+47 Ar1 Run 45+47 Ar3 Run 45+47	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
51/63	2021/03/09 2021/03/23	3	Ar2 2020/10 Ar1&3 2020/10	12	Ar2 42 Ar1 30 Ar3 29	y	y	Ar2 Run 45+47 Ar1 Run 45+47 Ar3 Run 45+47	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
52/64	2021/05/28 2021/05/29	3	Ar2 2020/10 Ar1&3 2020/10	0	n/a	n	y	Ar2 Run 45+47 Ar1 Run 45+47 Ar3 Run 45+47	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
55/67	2021/10/26 2021/11/09	3	Ar2 2021/10 Ar1&3 2021/10	16	Ar2 149 Ar1 86 Ar3 90	y	y	Ar2 Run 55-57 Ar1 Run 55-57 Ar3 Run 55-57	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
56/68	2021/11/15 2021/11/30	3	Ar2 2021/10 Ar1&3 2021/10	6	Ar2 73 Ar1 48 Ar3 51	y	y	Ar2 Run 55-57 Ar1 Run 55-57 Ar3 Run 55-57	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
57/69	2022/01/11 2022/01/25	3	Ar2 2021/10 Ar1&3 2021/10	11	Ar2 154 Ar1 109 Ar3 118	y	y	Ar2 Run 55-57 Ar1 Run 55-57 Ar3 Run 55-57	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
58/70	2022/02/01 2022/02/15	3	Ar2 2021/10 Ar1&3 2021/10	6	Ar2 93 Ar1 87 Ar3 92	y	y	Ar2 Run 55-57 Ar1 Run 55-57 Ar3 Run 55-57	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39

Run* Nika2/Cryo	Dates	DAQ version	Sweep	# Beam maps	# Flux Calib.**	Calib.*** processed	DAFs available	RPP version	Flux calib factor
59/71	2022/02/22 2022/03/08	3	Ar2 2021/10 Ar1&3 2021/10	5	Ar2 24 Ar1 24 Ar3 13	y	y	Ar2 Run 55-57 Ar1 Run 55-57 Ar3 Run 55-57	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
60/72	2022/10/11 2022/11/01	3	Ar2 2022/10 Ar1&3 2022/10	5 used all together	Ar2 54 Ar1 36 Ar3 41	y	y	Ar2 Run 60-62 Ar1 Run 60-62 Ar3 Run 60-62	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
61/73	2022/11/08 2022/11/29	3	Ar2 2022/10 Ar1&3 2022/10		Ar2 313 Ar1 256 Ar3 254	y	y	Ar2 Run 60-62 Ar1 Run 60-62 Ar3 Run 60-62	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
62/74	2022/12/06 2022/12/13	3	Ar2 2022/10 Ar1&3 2022/10		Ar2 11 Ar1 8 Ar3 6	y	y	Ar2 Run 60-62 Ar1 Run 60-62 Ar3 Run 60-62	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
63/75	2023/01/10 2023/01/31	3	Ar2 2022/10 Ar1&3 2022/10	4	Ar2 211 Ar1 134 Ar3 131	y	y	Ar2 Run 60-62 Ar1 Run 60-62 Ar3 Run 60-62	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
65/77	2024/02/13 2024/02/27	3	Ar2 2024/01 Ar1&3 2024/01	Runs 64-66: 4/13 used	Ar2 43 Ar1 26 Ar3 25	y	y	Ar2 Run 64-66 Ar1 Run 64-66 Ar3 Run 64-66	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
66/78	2024/03/05 2024/03/19	3	Ar2 2024/01 Ar1&3 2024/01		Ar2 46 Ar1 30 Ar3 27	y	y	Ar2 Run 64-66 Ar1 Run 64-66 Ar3 Run 64-66	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
67/79 (test)	2024/08/12 2024/08/25	3	Ar2 2024/01 Ar1&3 2024/01	6 taken	Ar2 81 Ar1 62 Ar3 52	y	y	Ar2 Run 64-66 Ar1 Run 64-66 Ar3 Run 64-66	Ar2 Run 34 Ar1 Run 39 Ar3 Run 39
68/80	2024/10/29 2024/11/12	3	Ar2 2024/10 Ar1&3 2024/10	4 used	Ar2 149 Ar1 114 Ar3 106	y	y	Ar2 Run 68 Ar1 Run 68 Ar3 Run 68	Ar2 Run 68 Ar1 Run 68 Ar3 Run 68
69/81	2024/11/19 2024/12/03	3	Ar2 2024/10 Ar1&3 2024/10	...	Ar2 201 Ar1 119 Ar3 123	y (cal only)	y	Ar2 Run 68 Ar1 Run 68 Ar3 Run 68	Ar2 Run 68 Ar1 Run 68 Ar3 Run 68
70/82	2025/01/07 2025/02/03	3	Ar2 2024/10 Ar1&3 2024/10	...	Ar2 149 Ar1 100 Ar3 108	y (cal only)	y	Ar2 Run 68 Ar1 Run 68 Ar3 Run 68	Ar2 Run 68 Ar1 Run 68 Ar3 Run 68
71/83	2025/02/11 2025/02/25	3	Ar2 2024/10 Ar1&3 2024/10	...	Ar2 83 Ar1 53 Ar3 58	y (cal only)	y	Ar2 Run 68 Ar1 Run 68 Ar3 Run 68	Ar2 Run 68 Ar1 Run 68 Ar3 Run 68
72/84 re-comm.	2025/03/18 2025/04/02	3	Ar2 2024/10 Ar1&3 2025/03	Ar2 3/9 Ar1 2/9 Ar3 3/9 used	Ar2 71 Ar1 91 Ar3 44	y	y	Ar2 Run 72 Ar1 Run 72 Ar3 Run 72	Ar2 Run 68 Ar1 Run 72 Ar3 Run 72
73/85 re-comm	2025/06	3	Ar2 2024/10 Ar1&3 2025/03		/	n	y	Ar2 Run 68 Ar1 Run 74 Ar3 Run 74	Ar2 Run 68 Ar1 Run 72 Ar3 Run 72
74/86 re-comm.	2025/07/12 2025/07/13	3	Ar2 2024/10 Ar1&3 2025/03	3	/	n	y	Ar2 Run 68 Ar1 Run 74 Ar3 Run 74	Ar2 Run 68 Ar1 Run 72 Ar3 Run 72
75/87 Re-comm. +pool+sch ool	2025/10/14 2025/11/01	3	Ar2 2025/10 Ar1&3 2025/10	9 used 13 taken	Ar2 123 Ar1 154 Ar3 111	y	y	Ar2 Run 75 Ar1 Run 75 Ar3 Run 75	Ar2 Run 75 Ar1 Run 75 Ar3 Run 75
76/88	2025/11/11 2025/11/25	3	Ar2 2025/10 Ar1&3 2025/10	4 taken for polar	Ar2 69 Ar1 91 Ar3 68	y	y	Ar2 Run 75 Ar1 Run 75 Ar3 Run 75	Ar2 Run 75 Ar1 Run 75 Ar3 Run 75

Run* Nika2/Cryo	Dates	DAQ version	Sweep	# Beam maps	# Flux Calib.**	Calib.*** processed	DAFs available	RPP version	Flux calib factor
77/89	2025/12/09 2025/12/16	3	Ar2 2025/10 Ar1&3 2025/10	0	Ar2 18 Ar1 27 Ar3 19	y	y	Ar2 Run 75 Ar1 Run 75 Ar3 Run 75	Ar2 Run 77 Ar1 Run 75 Ar3 Run 77
78/90	2026/01/06 2026/01/27	3	Ar2 2025/10 Ar1&3 2025/10	10	Ar2 222 Ar1 206 Ar3 189	y	y	Ar2 Run 75 Ar1 Run 75 Ar3 Run 75	Ar2 Run 78 Ar1 Run 78 Ar3 Run 78
79/91	2026/02/10 2026/03/03	3	Ar2 2025/10 Ar1&3 2025/10	18 taken	Ar2 162 Ar1 182 Ar3 136	y	y	Ar2 Run 75 Ar1 Run 75 Ar3 Run 75	Ar2 Run 78 Ar1 Run 78 Ar3 Run 78
80/92 re-comm	2026/03/24 2026/03/31	3	Ar2 2025/10 Ar1 2025/10 Ar3 2026/03	5 taken	Ar2 32 Ar1 50 Ar3 46	y	y	Ar2 Run 75 Ar1 Run 75 Ar3 Run 80 ☺	Ar2 Run 80 Ar1 Run 80 Ar3 Run 80

* only science pools are listed (plus few extras)
** calib. and pointing scans that made it to the shown plots
*** beam maps *and* flux calibrators
☺ preliminary

Statistics table

Here we summarize few additional pieces of information about the calibration files, namely the r.m.s. of the flux calibration and the number of identified DRPs. Figures are shown at the end of this document.

As described in the previous Sections, the flux calibration factors are computed using the data of NIKA2 runs with the best observing conditions for a given instrumental configuration. For each other run in the same configuration, we apply the best calibration factors and we compute the statistics of the derived fluxes, as compared to the intrinsic fluxes of the calibrators (which are well known sources). The following Table lists the percentual r.m.s. around the average flux in each run. Two values are given for each case: one computed on all scans (day+night); and one computed on night-only scans. All values have been derived after applying the telescope's gain-elevation correction (for the MB, as derived by RZ) to the data and using the line-of-sight extinction correction if available (NKSLEX method).

DRPs are mainly cross-talking KIDs and their list is checked and updated at least at each new *sweep*.

Table 2: additional statistics of calibration files

Run* Nika2/Cryo	Dates	# Flux Calib.**	NKSLEX avail.	Ar2 % r.m.s. flux calib.***	Ar1 % r.m.s. flux calib.***	Ar3 % r.m.s. flux calib.***	# DRPs
12/25	2017/10/24 2017/10/31	Ar2 145 Ar1 106 Ar3 103	y	3.3 2.3	4.6 4.5	4.5 4.5	Ar2 105 Ar1 132 Ar3 235
14/27	2018/01/16 2018/01/23	Ar2 100 Ar1 96 Ar3 81	y	3.6 3.6	6.8 3.5	8.0 4.6	Ar2 105 Ar1 81 Ar3 235
15/28	2018/02/13 2018/02/20	Ar2 75 Ar1 71 Ar3 76	y	2.7 2.5	6.7 7.3	7.1 7.5	Ar2 105 Ar1 81 Ar3 235
17/30	2018/03/13 2018/03/20	Lost because of bad weather					
18/31	2018/05/22 2018/05/29	Ar2 21 Ar1 19 Ar3 23	y	2.7 2.7	5.2 5.2	11.1 11.1	Ar2 105 Ar1 81 Ar3 235
22/36	2018/10/02 2018/10/09	Lost because of DAQ v2 malfunctioning					
23/37	2018/10/30 2018/11/06	Ar2 57 Ar1 28 Ar3 33	y	3.5 3.1	5.6 5.7	5.5 5.5	Ar2 102 Ar1 89 Ar3 235
24/38	2018/11/20 2018/11/27	Ar2 54 Ar1 25 Ar3 22	y	2.7 1.6	6.1 6.5	6.6 7.0	Ar2 102 Ar1 89 Ar3 235
26/40	2019/01/15 2019/01/22	Ar2 41 Ar1 34 Ar3 34	y	2.2 0.9	4.4 2.2	4.3 2.6	Ar2 102 Ar1 89 Ar3 235
27/41	2019/01/29 2019/02/05	Ar2 31 Ar1 29 Ar3 28	y	2.4 1.0	5.3 2.8	5.0 2.3	Ar2 102 Ar1 89 Ar3 235
28/42	2019/02/12 2019/02/19	Ar2 58 Ar1 45 Ar3 45	y	2.0 2.2	4.4 4.4	4.3 4.1	Ar2 102 Ar1 89 Ar3 235
29/43	2019/03/05 2019/03/12	Ar2 26 Ar1 28 Ar3 26	y	2.5 2.3	5.4 6.1	5.6 6.0	Ar2 102 Ar1 89 Ar3 235

Run* **Nika2/Cryo**	**Dates**	**# Flux Calib.****	**NKSLEX avail.**	**Ar2 % r.m.s. flux calib.*****	**Ar1 % r.m.s. flux calib.*****	**Ar3 % r.m.s. flux calib.*****	**# DRPs**
30/44	2019/03/19 2019/03/26	Ar2 41 Ar1 22 Ar3 21	Old sweep y New sweep n	3.2 3.0	5.2 3.0	11.2 8.5	Ar2 102 Ar1 89/82 Ar3 235/143
34/48	2019/10/08 2019/10/14	Ar2 138 Ar1 110 Ar3 107	y	2.6 2.5	8.1 7.9	8.5 7.6	Ar2 94 Ar1 136 Ar3 242
35/48b	2019/10/15 2019/10/22						
36/49	2019/10/29 2019/11/04	Ar2 73 Ar1 39 Ar3 47	y	5.5 5.6	6.3 6.6	7.8 8.2	Ar2 94 Ar1 136 Ar3 242
37/49b	2019/11/05 2019/11/12						
38/50	2019/12/10 2019/12/17	Ar2 52 Ar1 41 Ar3 32	y	1.7 1.7	4.2 3.0	4.0 4.0	Ar2 94 Ar1 136 Ar3 242
39/51	2020/01/14 2020/01/21	Ar2 70 Ar1 60 Ar3 64	y	2.2 2.2	5.2 3.1	6.1 5.0	Ar2 94 Ar1 125 Ar3 260
40/52	2020/01/28 2020/02/04	Ar2 66 Ar1 60 Ar3 56	y	2.8 4.5	6.3 5.6	6.4 5.2	Ar2 94 Ar1 125 Ar3 260
41/53	2020/02/11 2020/02/18	Ar2 146 Ar1 119 Ar3 123	y	2.8 3.1	5.3 4.6	5.7 5.5	Ar2 94 Ar1 125 Ar3 260
43/55	2020/03/10 2020/03/17	Ar2 116 Ar1 76 Ar3 82	y	6.6 3.6	14.7 23.6	15.1 22.8	Ar2 94 Ar1 125 Ar3 260
45/57	2020/10/20 2020/11/03	Ar2 100 Ar1 84 Ar3 80	y	2.6 2.7	5.1 4.8	4.2 4.2	Ar2 121 Ar1 177 Ar3 299
47/59	2020/11/17 2020/11/24	Ar2 70 Ar1 56 Ar3 58	y	1.9 1.8	3.9 4.0	4.3 4.6	Ar2 121 Ar1 177 Ar3 299
48/60	2020/12/08 2020/12/15	Ar2 21 Ar1 4 Ar3 5	y	5.7 n/a	1.0 n/a	9.5 n/a	Ar2 121 Ar1 177 Ar3 299
49/61	2021/01/12 2021/01/26	Ar2 96 Ar1 77 Ar3 75	y	2.1 1.7	4.5 3.9	4.4 4.1	Ar2 121 Ar1 177 Ar3 299
50/62	2021/02/09 2021/02/23	Ar2 49 Ar1 45 Ar3 44	y	2.7 n/a	5.5 n/a	6.1 n/a	Ar2 121 Ar1 177 Ar3 299
51/63	2021/03/09 2021/03/23	Ar2 42 Ar1 30 Ar3 29	y	6.2 4.9	8.6 7.3	9.7 6.8	Ar2 121 Ar1 177 Ar3 299
52/64	2021/05/28 2021/05/29	n/a	n/a	n/a	n/a	n/a	Ar2 121 Ar1 177 Ar3 299
55/67	2021/10/26 2021/11/09	Ar2 149 Ar1 86 Ar3 90	y	2.6 2.6	6.3 6.8	8.0 7.5	Ar2 102† Ar1 132† Ar3 178†

Run* Nika2/Cryo	Dates	# Flux Calib.**	NKSLEX avail.	Ar2 % r.m.s. flux calib.***	Ar1 % r.m.s. flux calib.***	Ar3 % r.m.s. flux calib.***	# DRPs
56/68	2021/11/15 2021/11/30	Ar2 73 Ar1 48 Ar3 51	y	3.5 2.9	6.0 5.7	5.9 5.7	Ar2 102 Ar1 132 Ar3 178
57/69	2022/01/11 2022/01/25	Ar2 154 Ar1 109 Ar3 118	y	5.1 4.7	4.3 4.1	5.2 5.0	Ar2 102 Ar1 132 Ar3 178
58/70	2022/02/01 2022/02/15	Ar2 93 Ar1 87 Ar3 92	y	2.5 2.6	6.0 4.9	6.1 5.2	Ar2 102 Ar1 132 Ar3 178
59/71	2022/02/22 2022/03/08	Ar2 24 Ar1 24 Ar3 13	y	2.9 2.4	5.3 5.5	5.2 5.2	Ar2 102 Ar1 132 Ar3 178
60/72	2022/10/11 2022/11/01	Ar2 54 Ar1 36 Ar3 41	y	2.4 2.3	3.5 3.5	4.9 4.9	Ar2 102 Ar1 132 Ar3 178
61/73	2022/11/08 2022/11/29	Ar2 313 Ar1 256 Ar3 254	y	3.4 3.5	6.8 7.3	6.9 7.2	Ar2 102 Ar1 132 Ar3 178
62/74	2022/12/06 2022/12/13	Ar2 11 Ar1 8 Ar3 6	y	3.0 2.9	3.4 3.8	2.8 3.2	Ar2 102 Ar1 132 Ar3 178
63/75	2023/01/10 2023/01/31	Ar2 211 Ar1 134 Ar3 131	y	3.6 3.8	7.0 7.3	6.9 6.7	Ar2 102 Ar1 132 Ar3 178
65/77	2024/02/13 2024/02/27	Ar2 43 Ar1 26 Ar3 25	y	2.7 3.0	7.8 9.2	7.5 9.9	Ar2 102 Ar1 132 Ar3 178
66/78	2024/03/05 2024/03/19	Ar2 46 Ar1 30 Ar3 27	y	5.4 4.2	10.4 10.3	8.5 7.4	Ar2 102 Ar1 132 Ar3 178
67/79 (tests)	2024/08/12 2024/08/25	Ar2 81 Ar1 62 Ar3 52	y	3.7 3.4	6.9 6.2	7.3 7.1	Ar2 102 Ar1 132 Ar3 178
68/80	2024/10/29 2024/11/12	Ar2 149 Ar1 114 Ar3 106	y	3.4 2.9	6.3 5.5	7.0 5.7	Ar2 102 Ar1 132 Ar3 178
69/81	2024/11/19 2024/12/03	Ar2 201 Ar1 119 Ar3 123	y	3.2 3.2	4.5 3.8	4.9 4.3	Ar2 102 Ar1 132 Ar3 178
70/82	2025/01/07 2025/02/03	Ar2 149 Ar1 100 Ar3 108	y	2.8 2.5	5.3 4.7	5.1 4.3	Ar2 102 Ar1 132 Ar3 178
71/83	2025/02/11 2025/02/25	Ar2 83 Ar1 53 Ar3 58	y	3.4 1.9	5.0 5.2	5.8 5.8	Ar2 102 Ar1 132 Ar3 178
72/84 re-comm.	2025/03/18 2025/04/02	Ar2 71 Ar1 91 Ar3 44	y	4.0 4.9	12.7 14.1	20.3 38.7	Ar2 102 Ar1 ... Ar3 ...
73/85 re-comm.	2025/06	/	n	/	/	/	/
74/86 re-comm.	2025/07/12 2025/07/13	/	n	/	/	/	/

Run* **Nika2/Cryo**	**Dates**	**# Flux Calib.****	**NKSLEX avail.**	**Ar2 % r.m.s. flux calib.*****	**Ar1 % r.m.s. flux calib.*****	**Ar3 % r.m.s. flux calib.*****	**# DRPs**
75/87 Re-comm. +pool+scho ol	2025/10/14 2025/11/01	Ar2 123 Ar1 154 Ar3 111	y	4.6 3.8	6.6 6.3	7.1 6.7	Ar2 102 Ar1 ... Ar3 ...
76/88	2025/11/11 2025/11/25	Ar2 69 Ar1 91 Ar3 68	y	4.4 3.5	7.9 6.8	8.0 7.5	Ar2 102 Ar1 ... Ar3 ...
77/89	2025/12/09 2025/12/16	Ar2 18 Ar1 27 Ar3 19	y	3.8 3.4	6.1 5.2	7.3 5.3	Ar2 102 Ar1 ... Ar3 ...
78/90	2026/01/06 2026/01/27	Ar2 222 Ar1 206 Ar3 189	y	7.6 6.4	7.2 6.5	8.0 7.1	Ar2 102 Ar1 ... Ar3 ...
79/91	2026/02/10 2026/03/03	Ar2 162 Ar1 182 Ar3 136	y	5.8 4.3	7.1 4.0	7.1 4.5	Ar2 102 Ar1 ... Ar3 ...
80/92 re-comm	2026/03/24 2026/03/31	Ar2 32 Ar1 50 Ar3 46	y	5.6 1.9	6.0 6.8	6.3 5.6	Ar2 102 Ar1 ... Ar3 ...

* only science pools are listed
** calib. and pointing scans that made it to the shown plots (i.e. after FWHM and other selections)
*** based on main beam flux analysis; two values of r.m.s. are given for each entry: the first is computed on all scans (day+night); the second is computed on night-only scans.
† starting with the NIKA2 run 55, the cross talking analysis uses a threshold of 5% in cross-talking intensity, while before it was using 3%. For this reason the number of DRP slightly decreased.

Figures of NIKA2 PIIC flux calibration statistics

see the *Summary of NIKA2 calibration files* for more details

Stefano Berta and Robert Zylka

v. 3.9.5; SB, Apr. 10, 2026

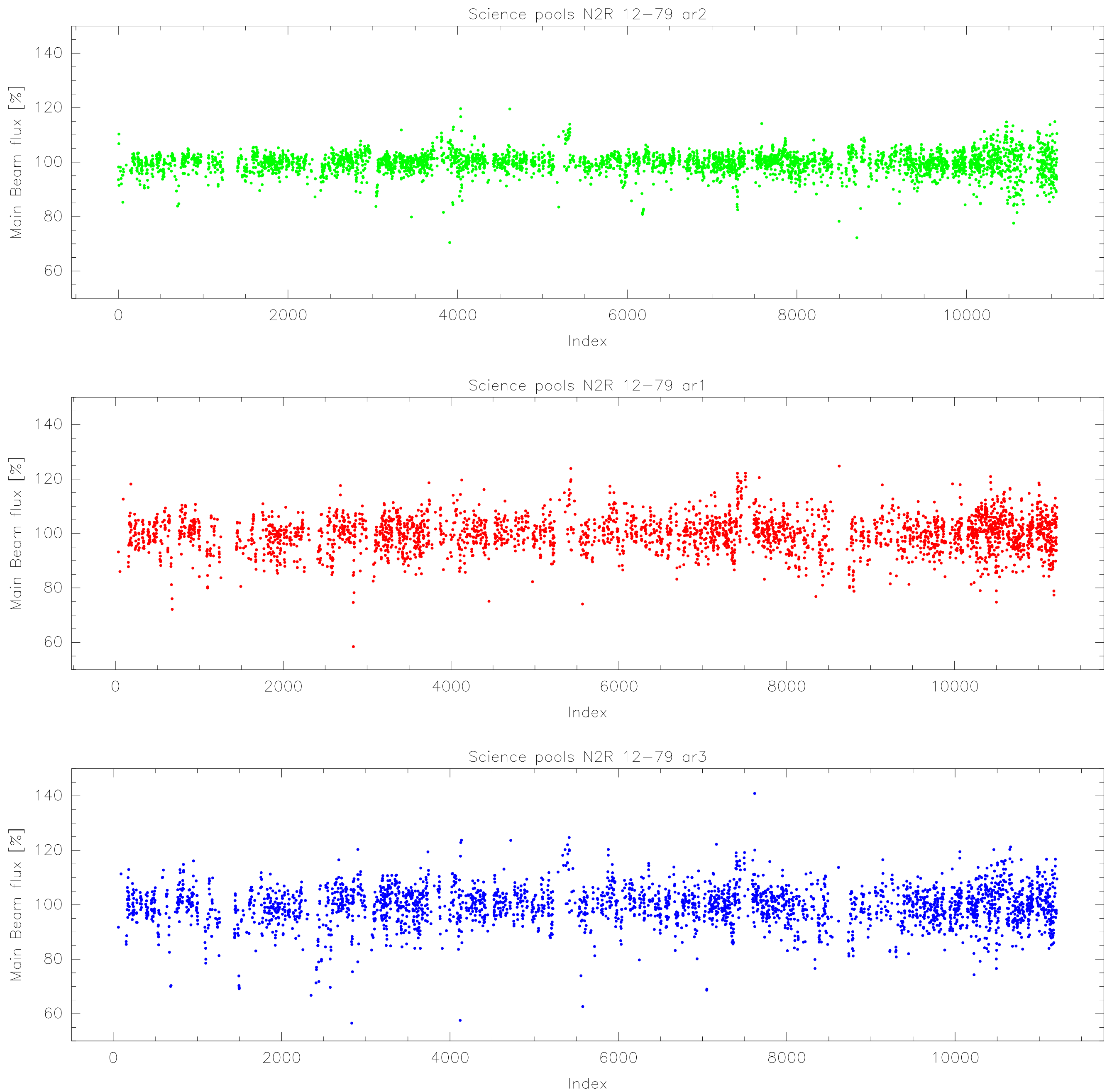

Figure 1: Retrieved flux percenteage of all calibrators used to derive the DAFs (see main text for details) of all NIKA2 *science* pools so far (runs 12 to 79). The three panels belong to the three NIKA2 arrays.

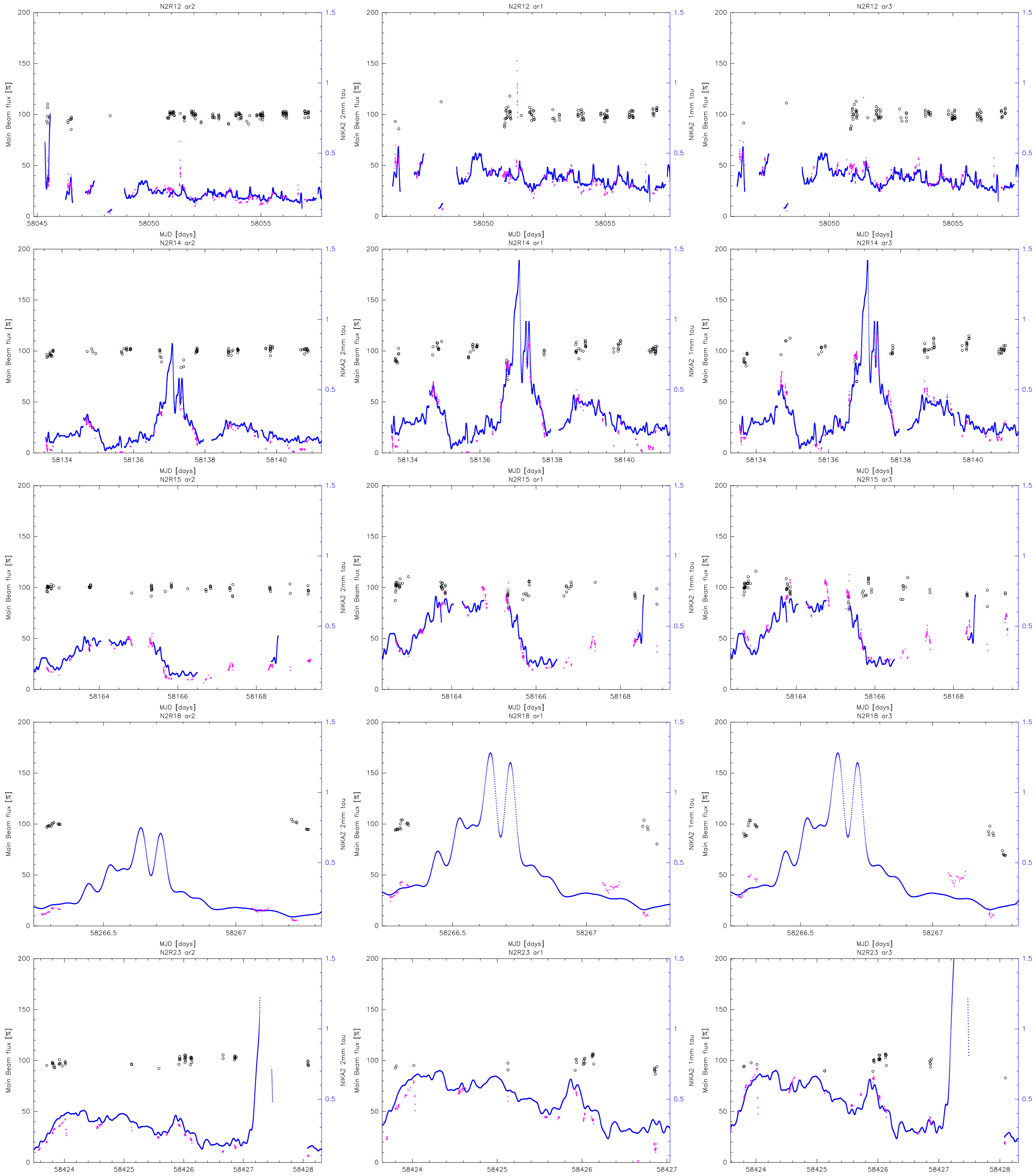

Figure 2: Distribution of the flux percentage retrieved for calibrators fitting the main beam with a Gaussian profile (black circles) for individual NIKA2 pools: runs 12, 14, 15, 18, 23. Left, central, right panels belong to Ar2, 1, 3, respectively. The atmospheric opacity given by the tau-meter and rescaled to NIKA2 bands is shown (blue dots); in pink the opacity along the observed line-of-sight of the scans is highlighted, as computed using sky load; if the tau-meter curve does not cover a scan, the value in the FITS header is used.

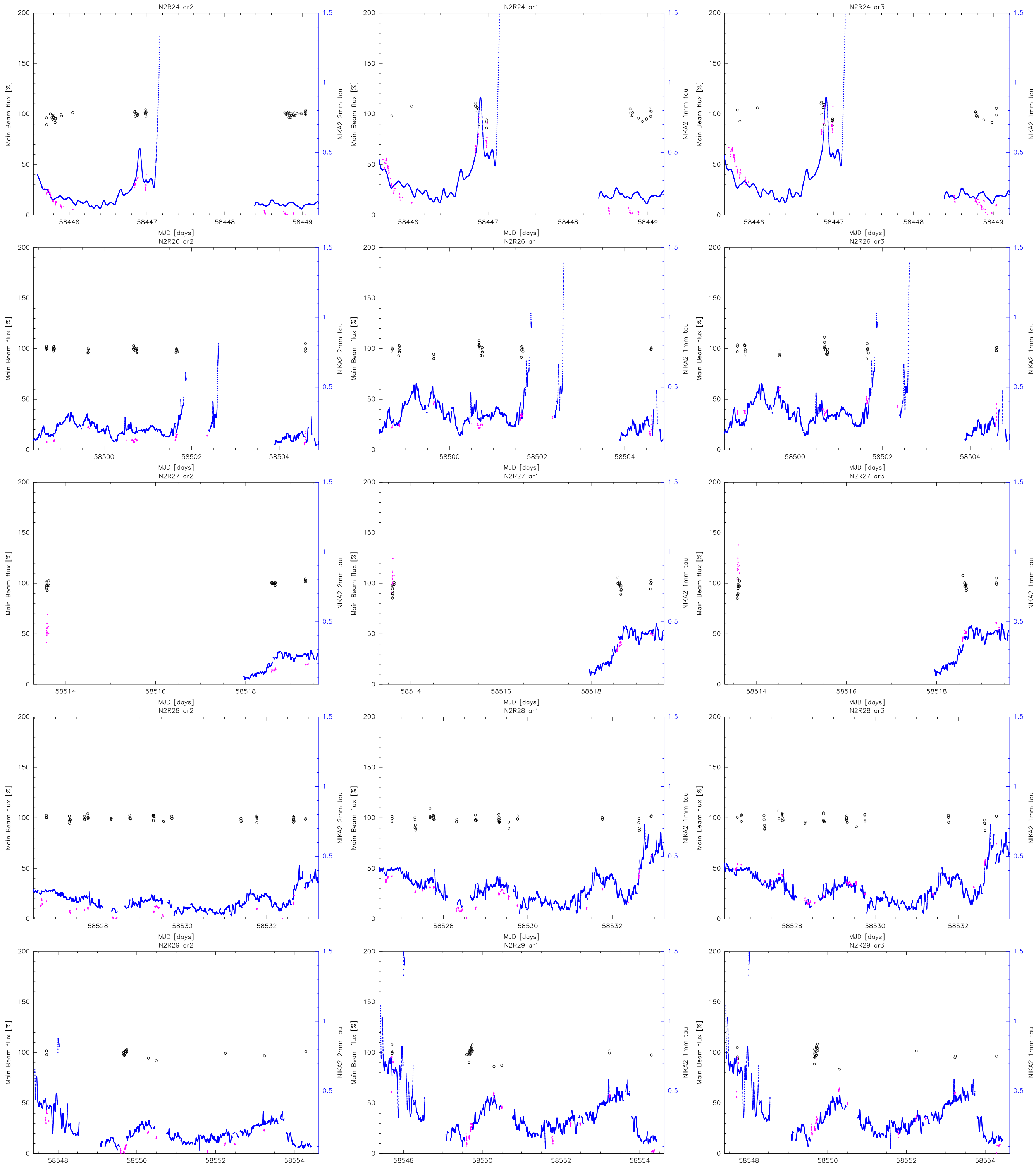

Figure 2: continued for runs 24, 26, 27, 28, 29.

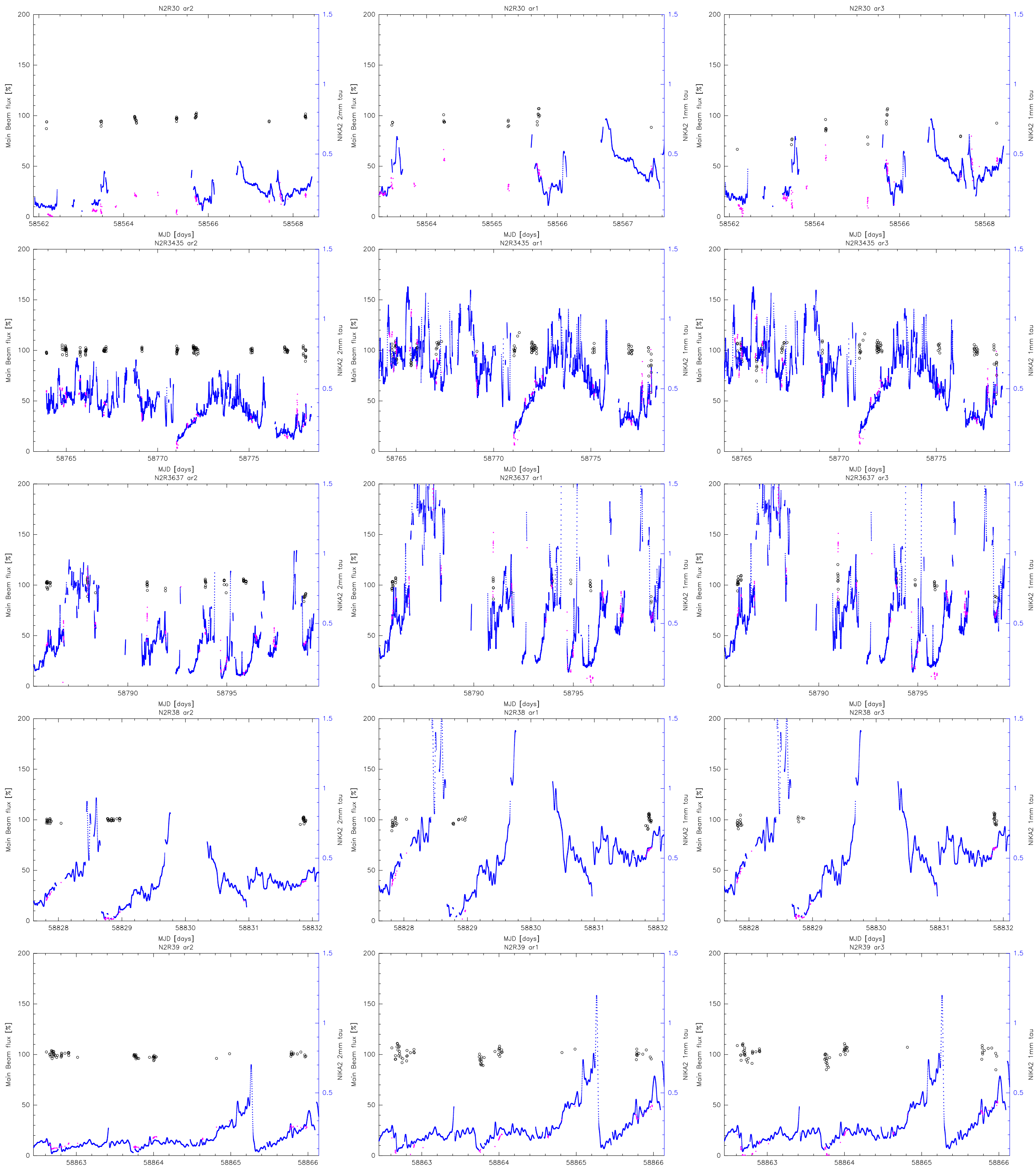

Figure 2: continued for runs 30, 34+35, 36+37, 38, 39.

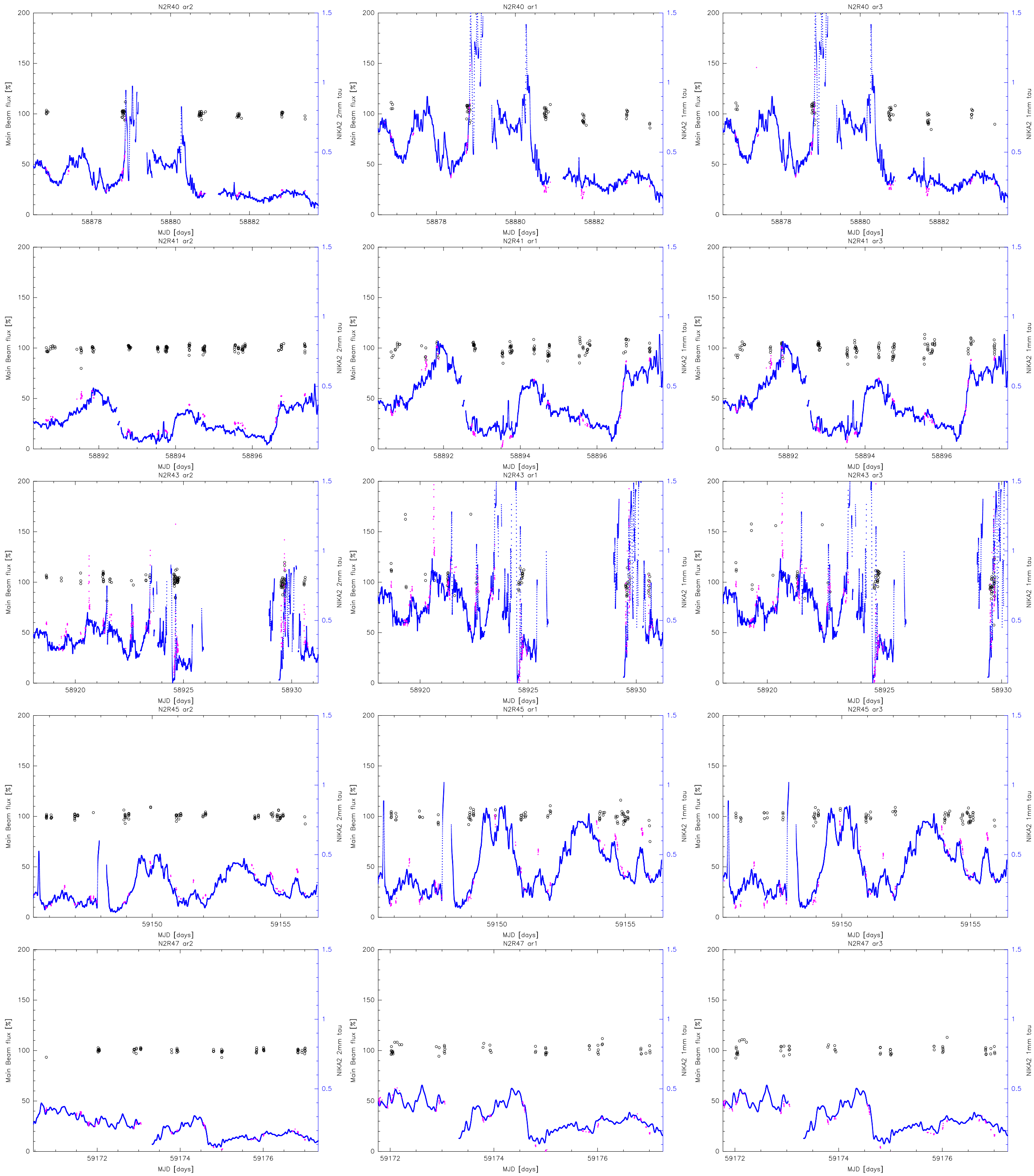

Figure 2: continued for runs 40, 41, 43, 45, 47.

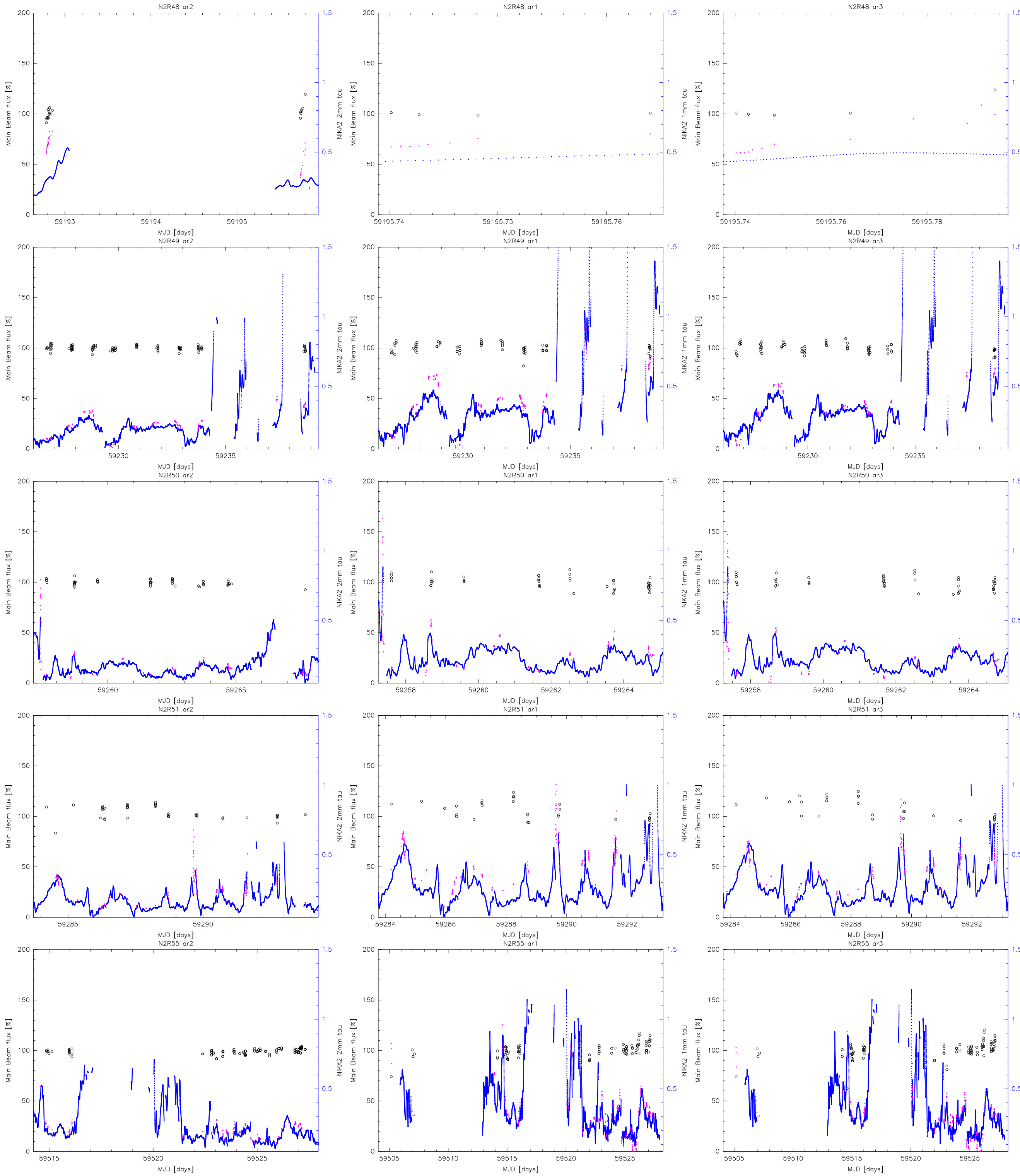

Figure 2: Continued for runs 48, 49, 50, 51, 55.

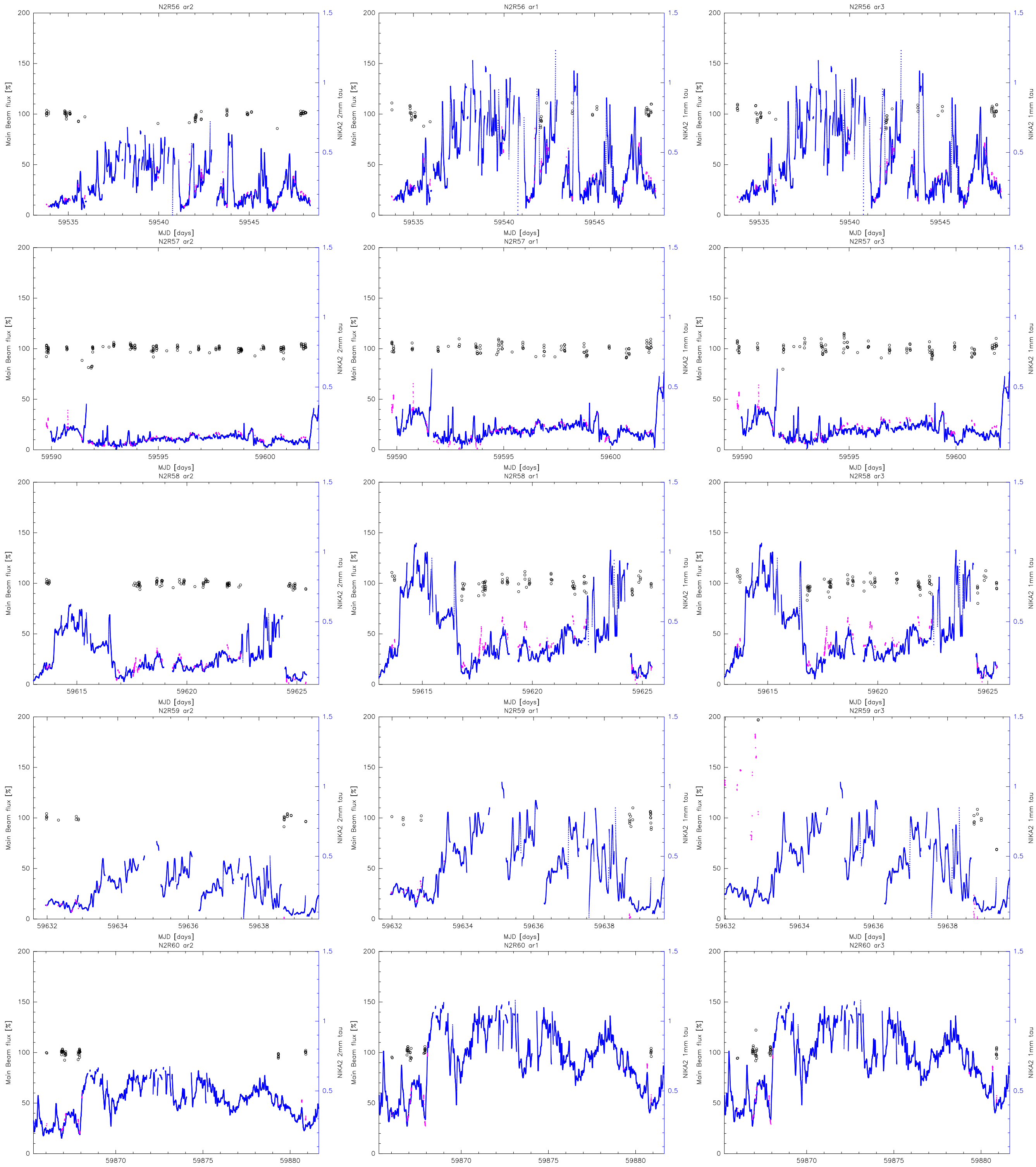

Figure 2: Continued for runs 56, 57, 58, 59, 60.

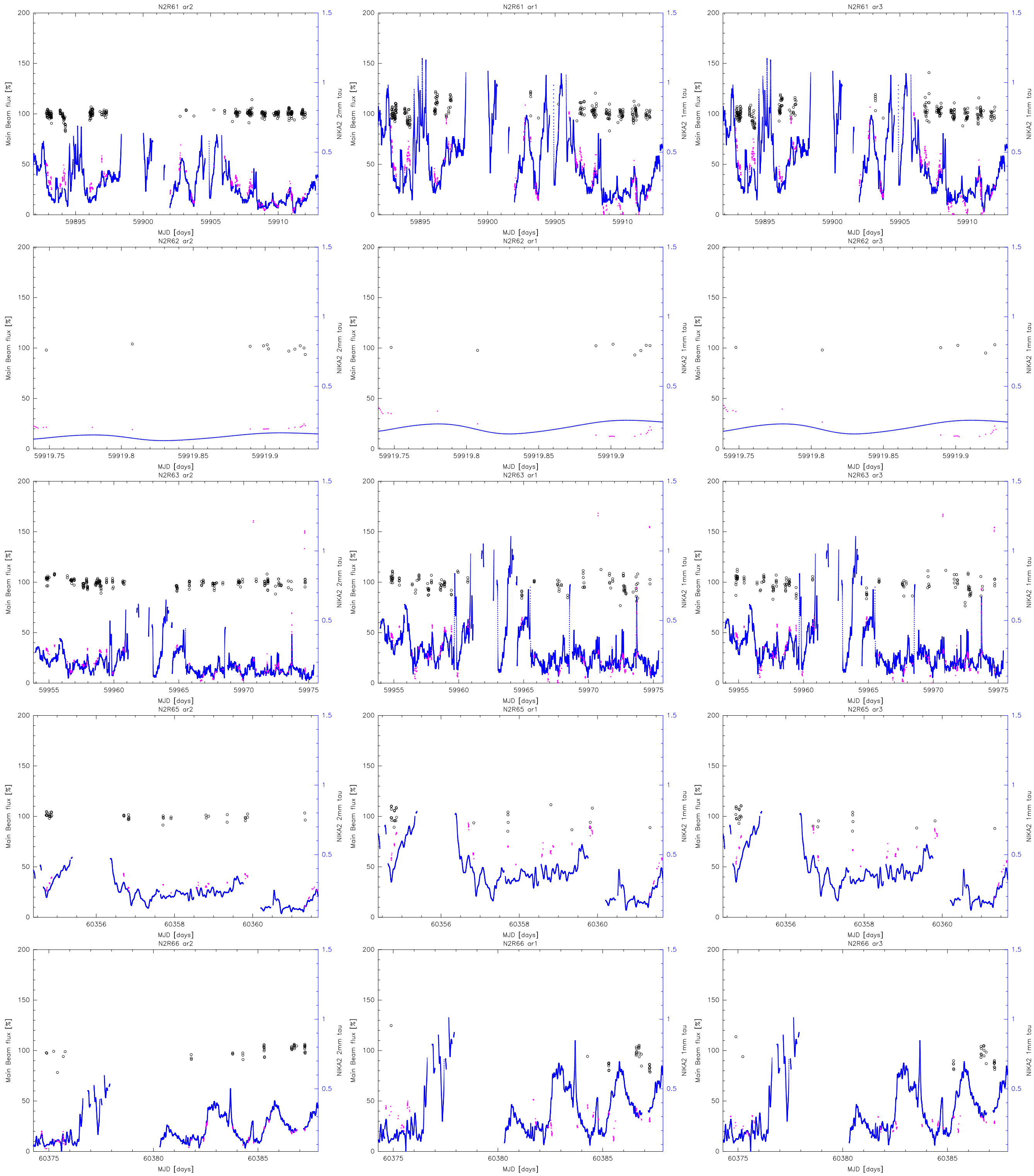

Figure 2: Continued for runs 61, 62, 63, 65, 66.

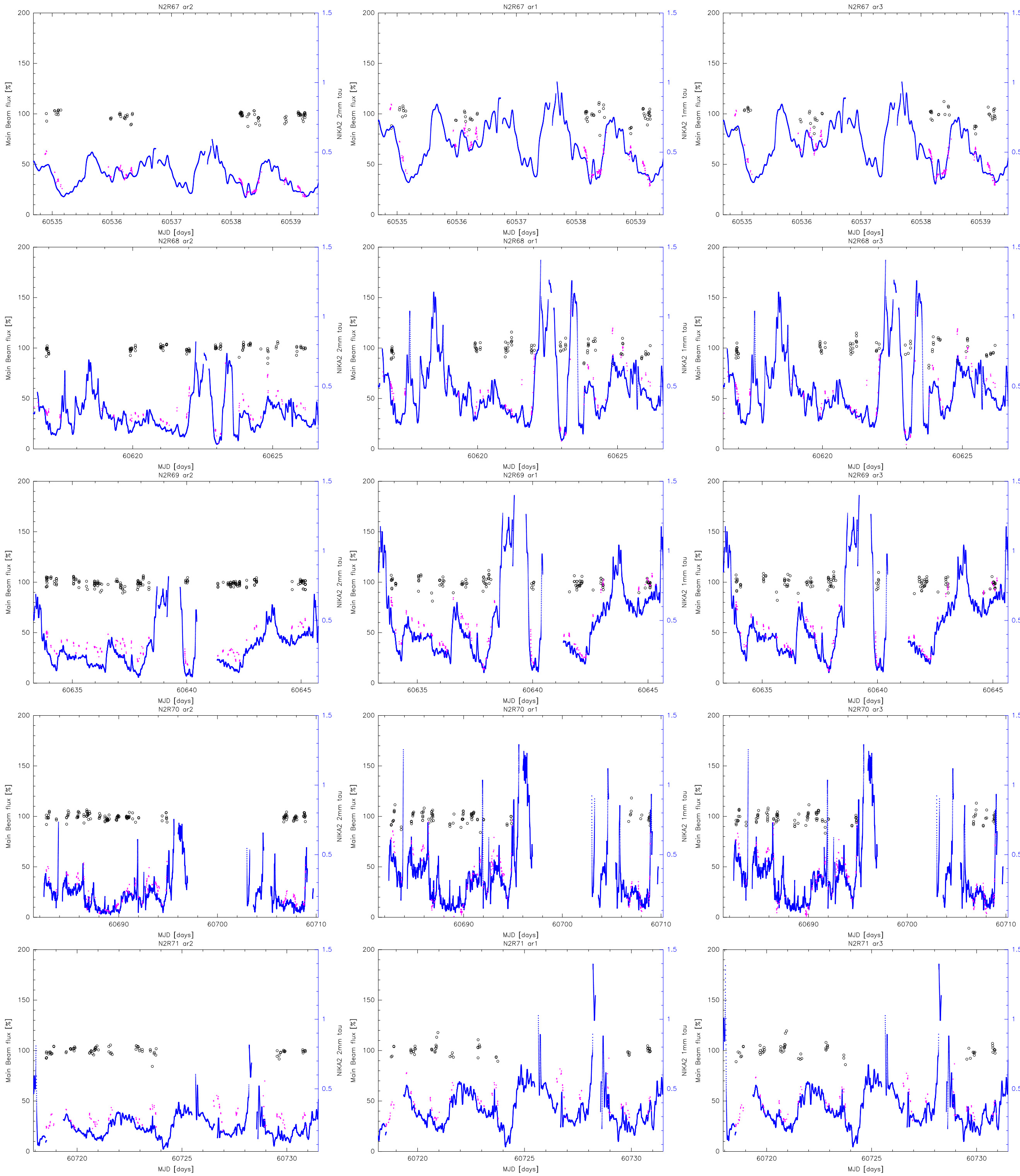

Figure 2: Continued for runs 67, 68, 69, 70, 71.

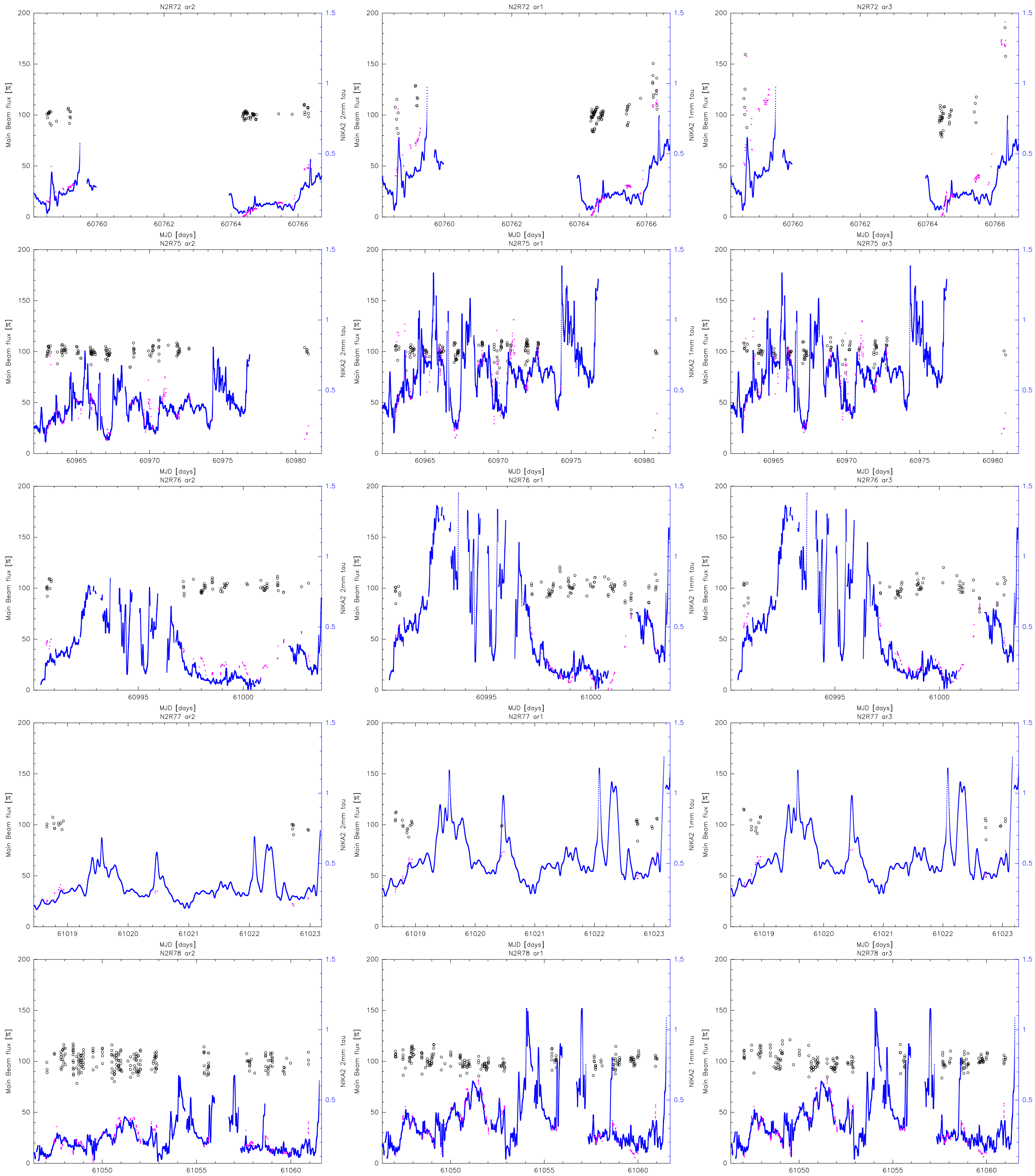

Figure 2: Continued for runs 72, 75, 76, 77, 78.

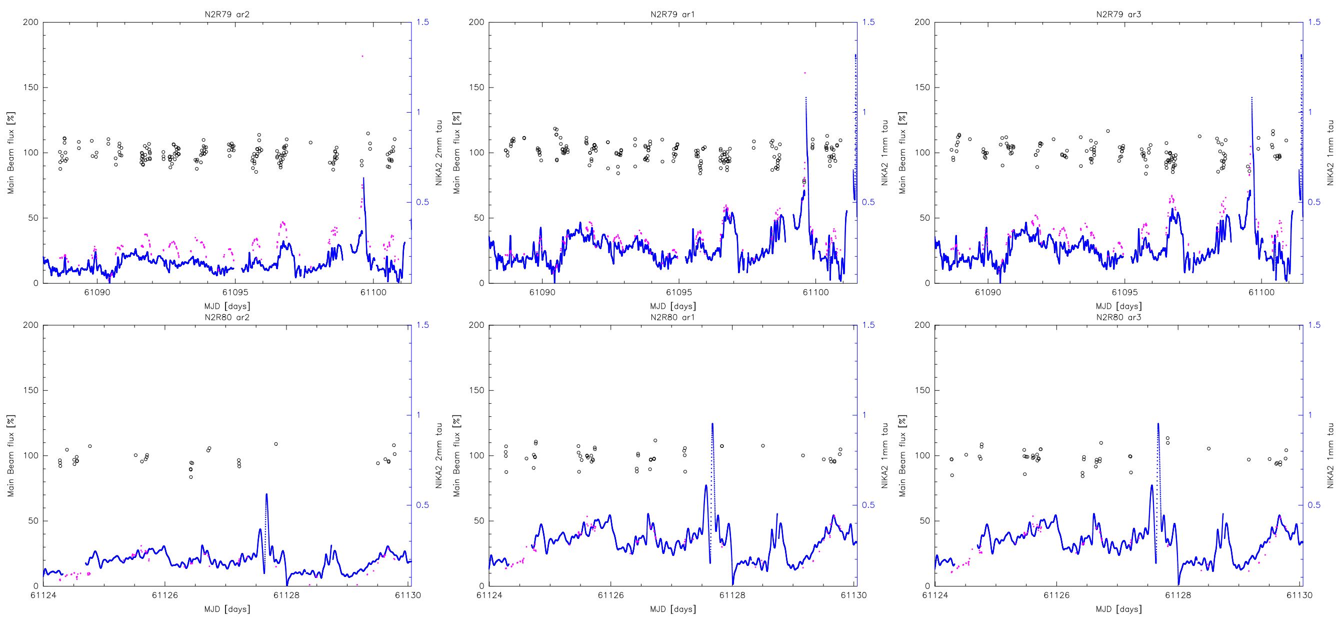

Figure 2: Continued for runs 79, 80.

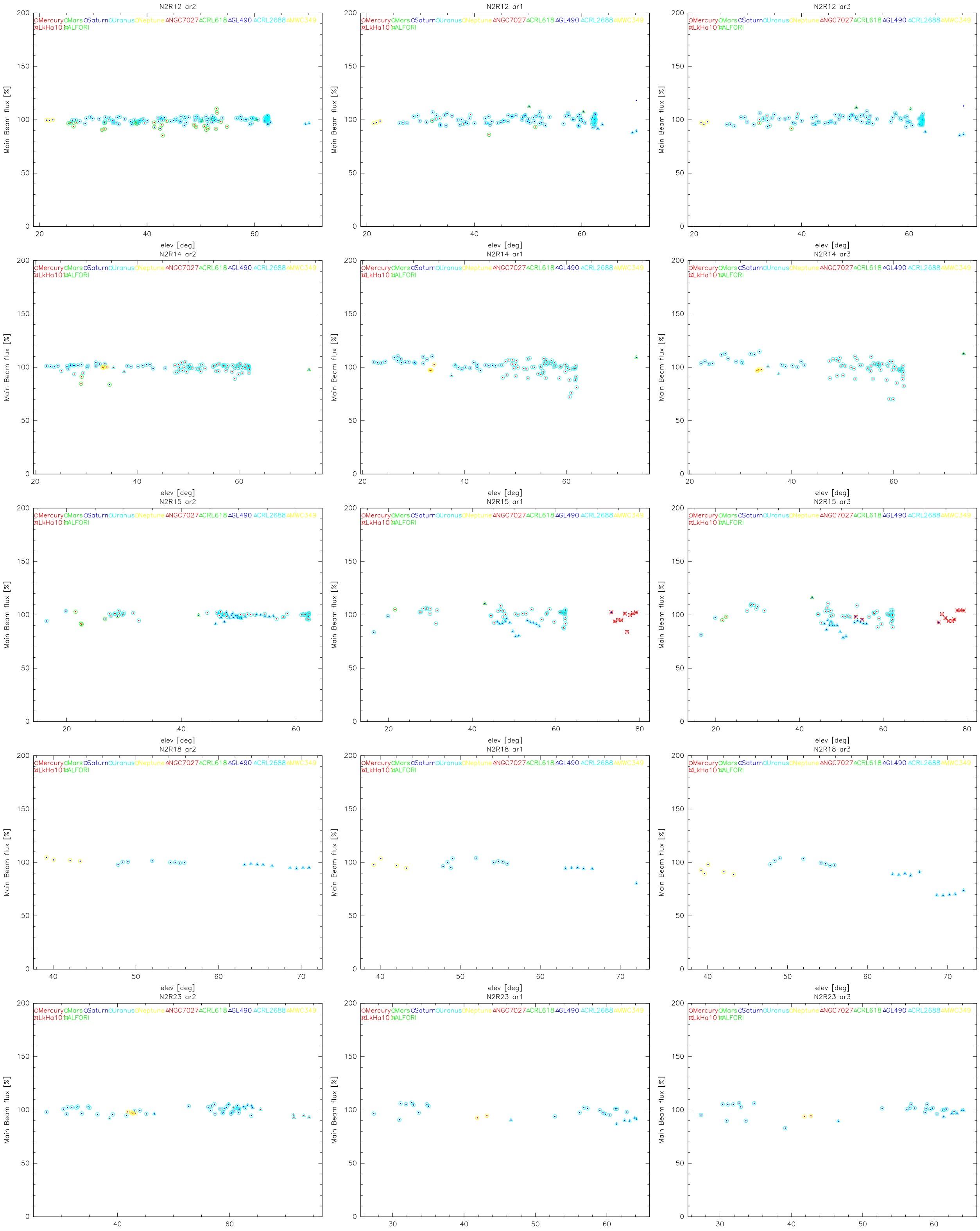

Figure 3: Main beam flux percentage (of intrinsic flux) as a function of elevation. NIKA2 runs 12, 14, 15, 18, 23. Fluxes are measured after applying the telescope's gain-elevation curve. Different calibrators are depicted with different symbols/colors. Red and blue circles mark scan taken during day- and night-time, respectively.

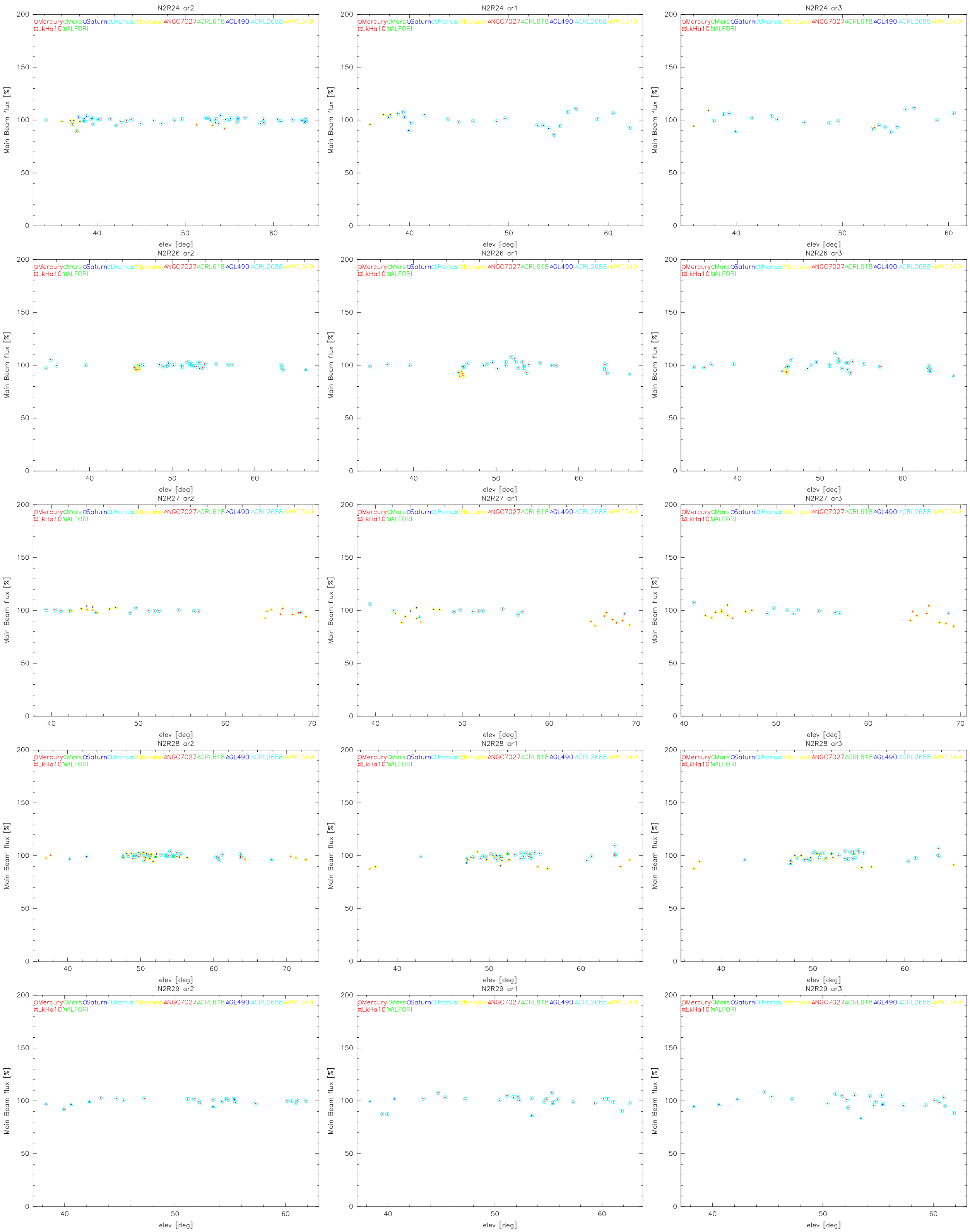

Figure 3: continued for runs 24, 26, 27, 28, 29.

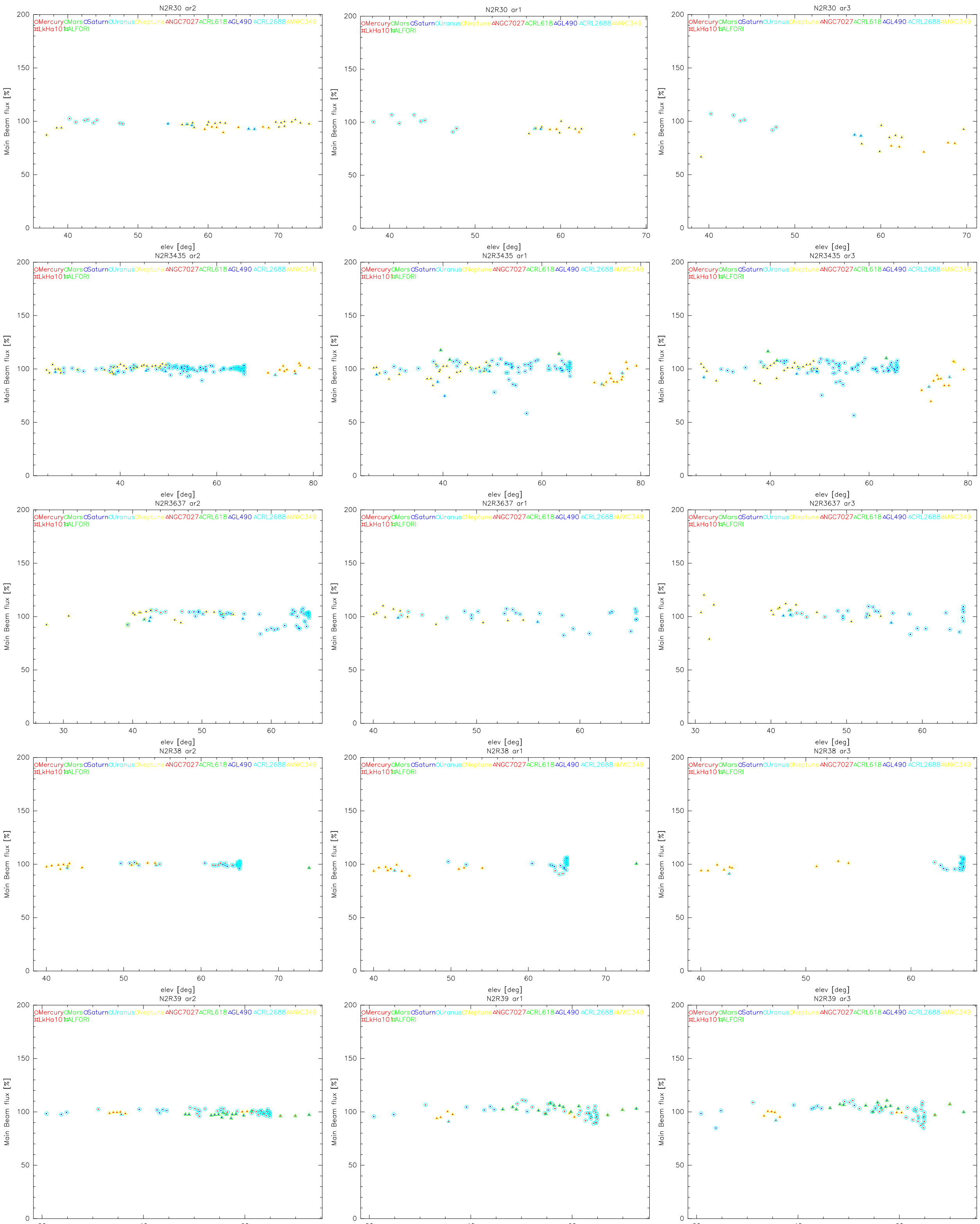

Figure 3: continued for runs 30, 34+35, 36+37, 38, 39.

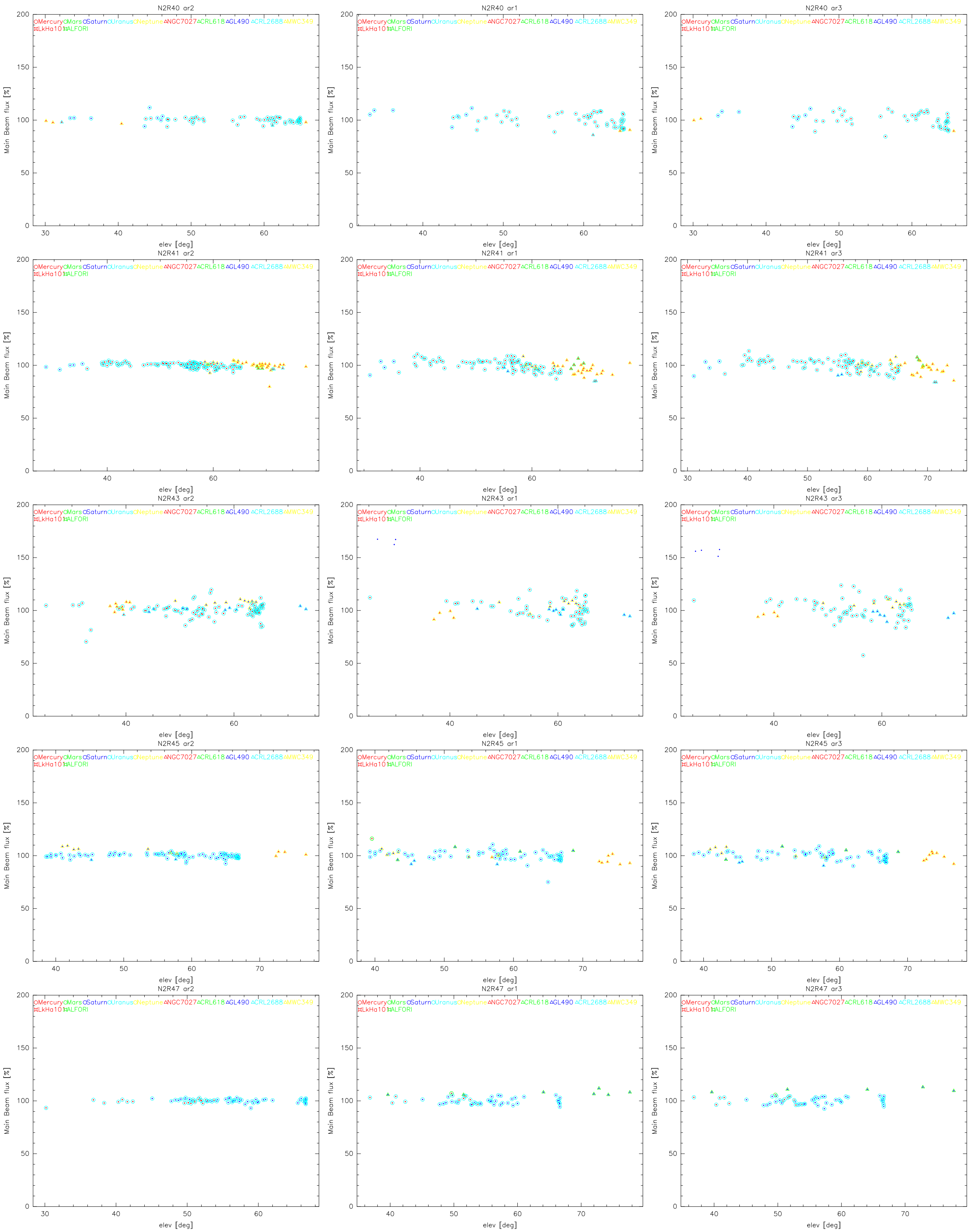

Figure 3: continued for runs 40, 41, 43, 45, 47.

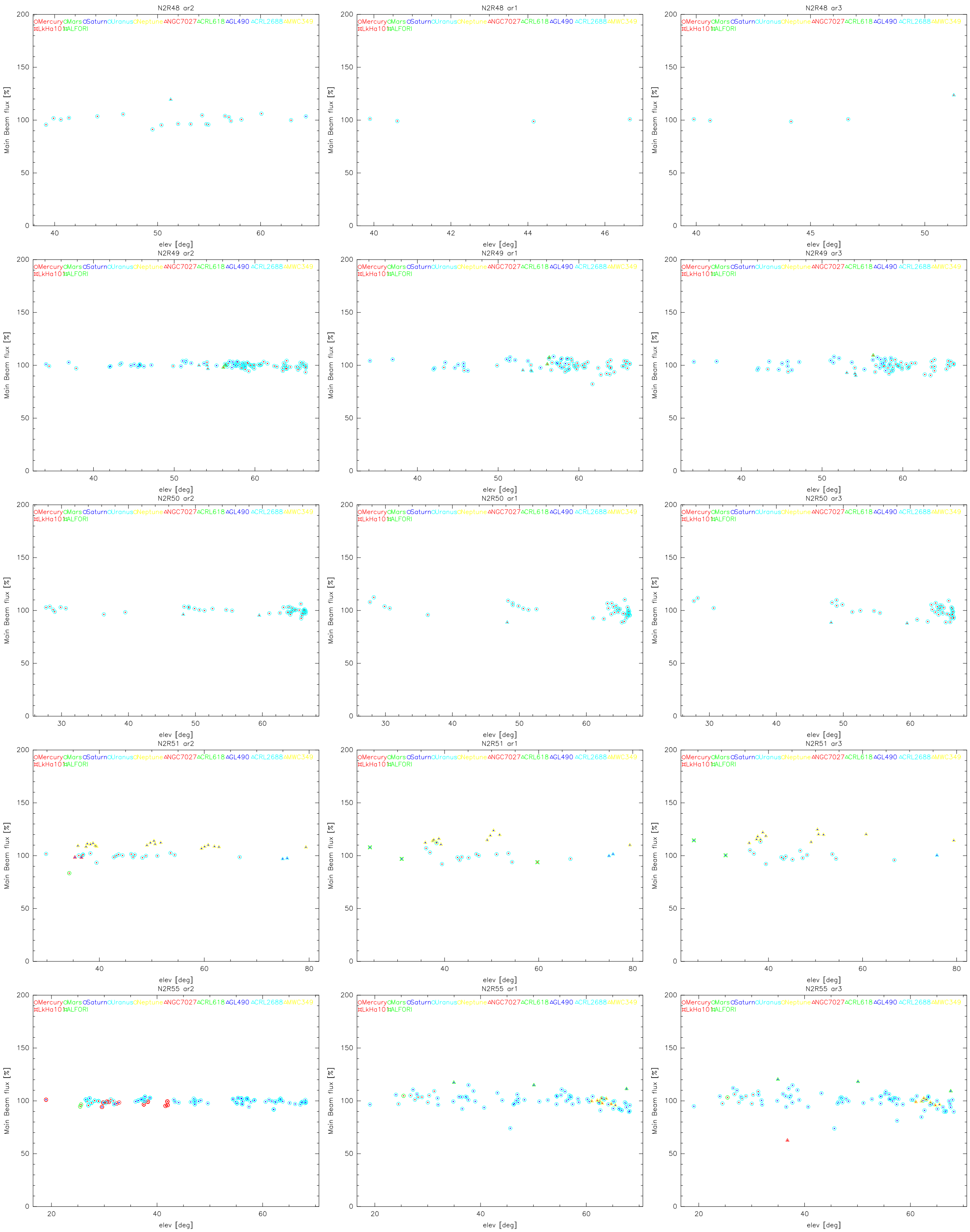

Figure 3: continued for runs 48, 49, 50, 51, 55.

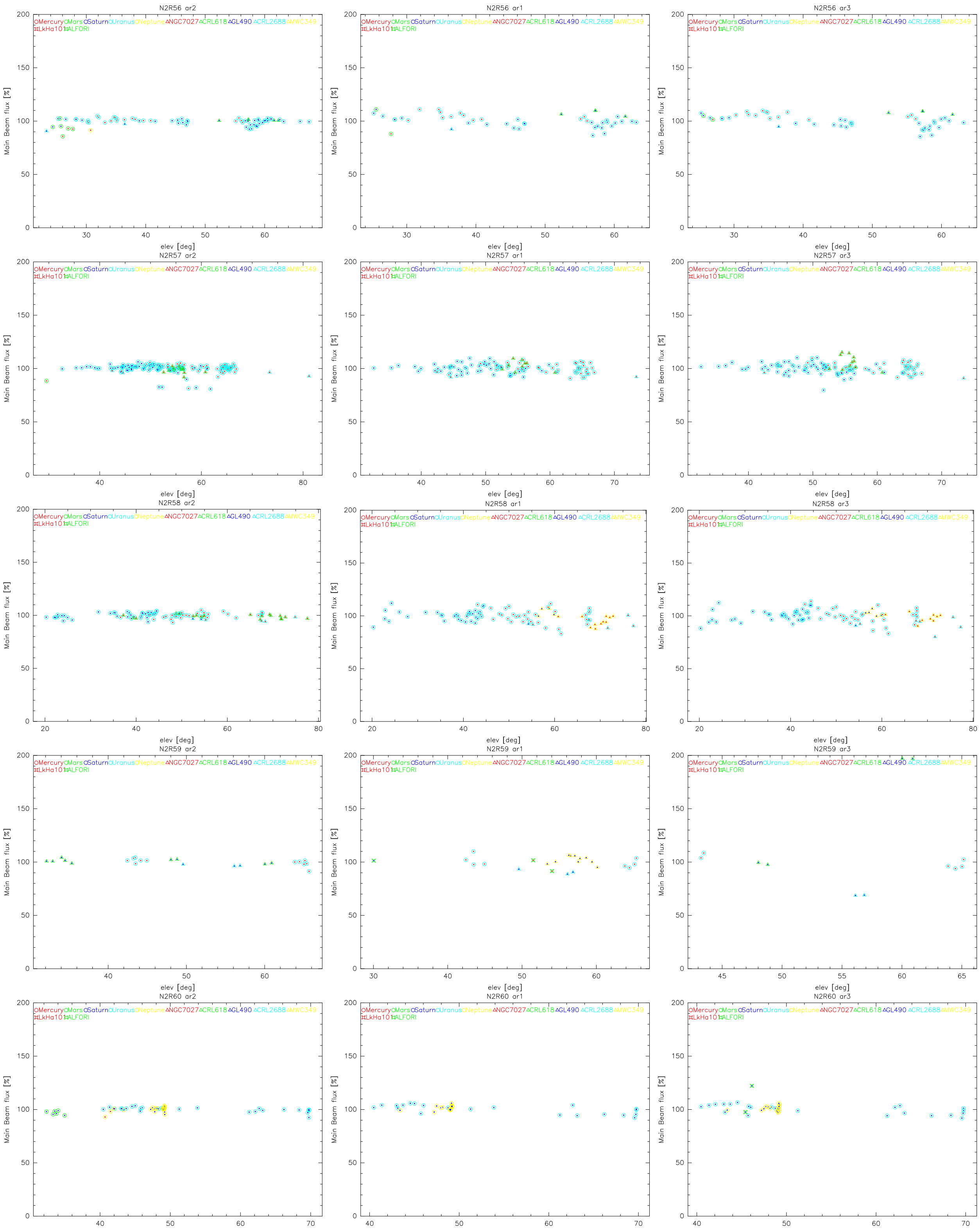

Figure 3: continued for runs 56, 57, 58, 59, 60.

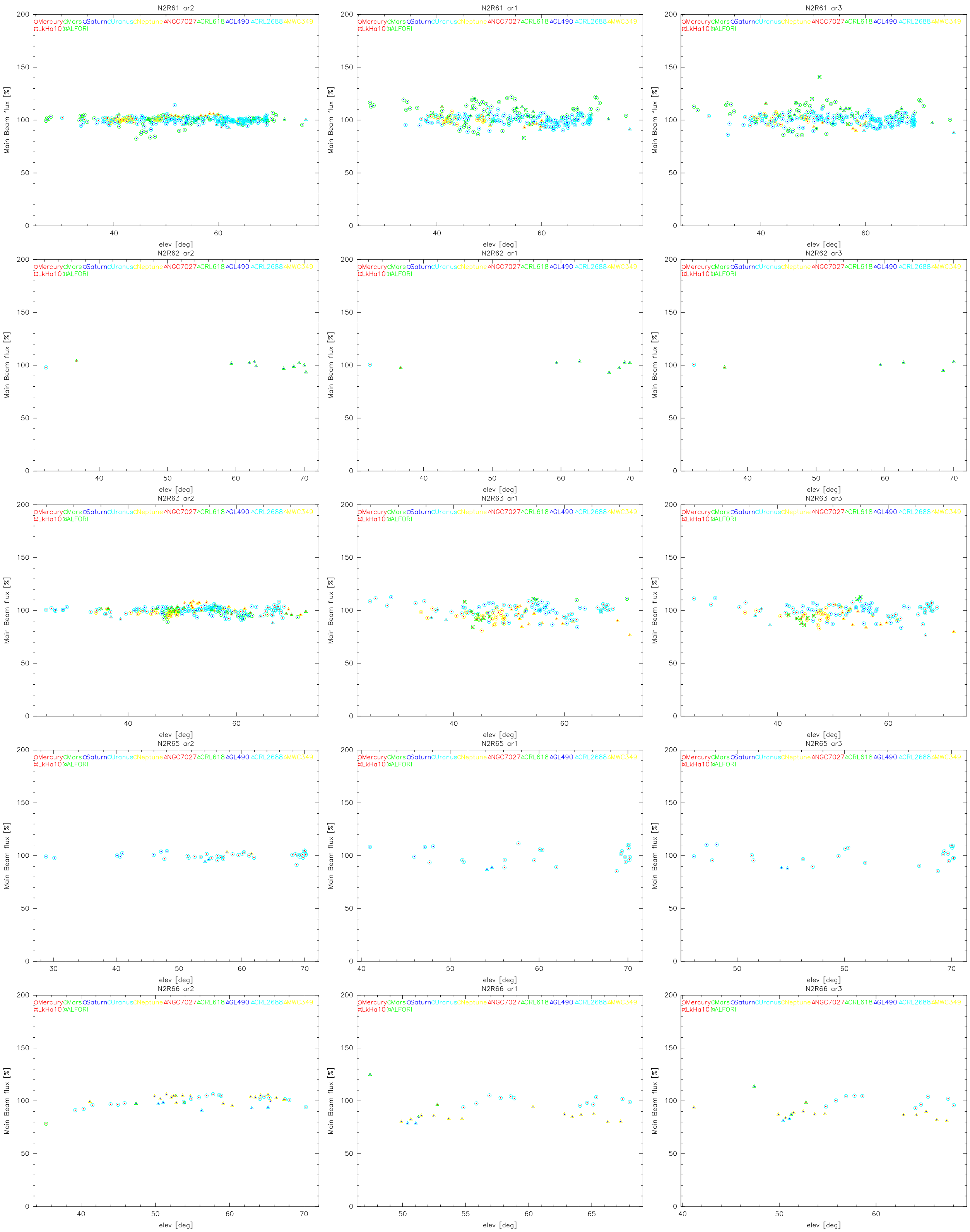

Figure 3: continued for runs 61, 62, 63, 65, 66.

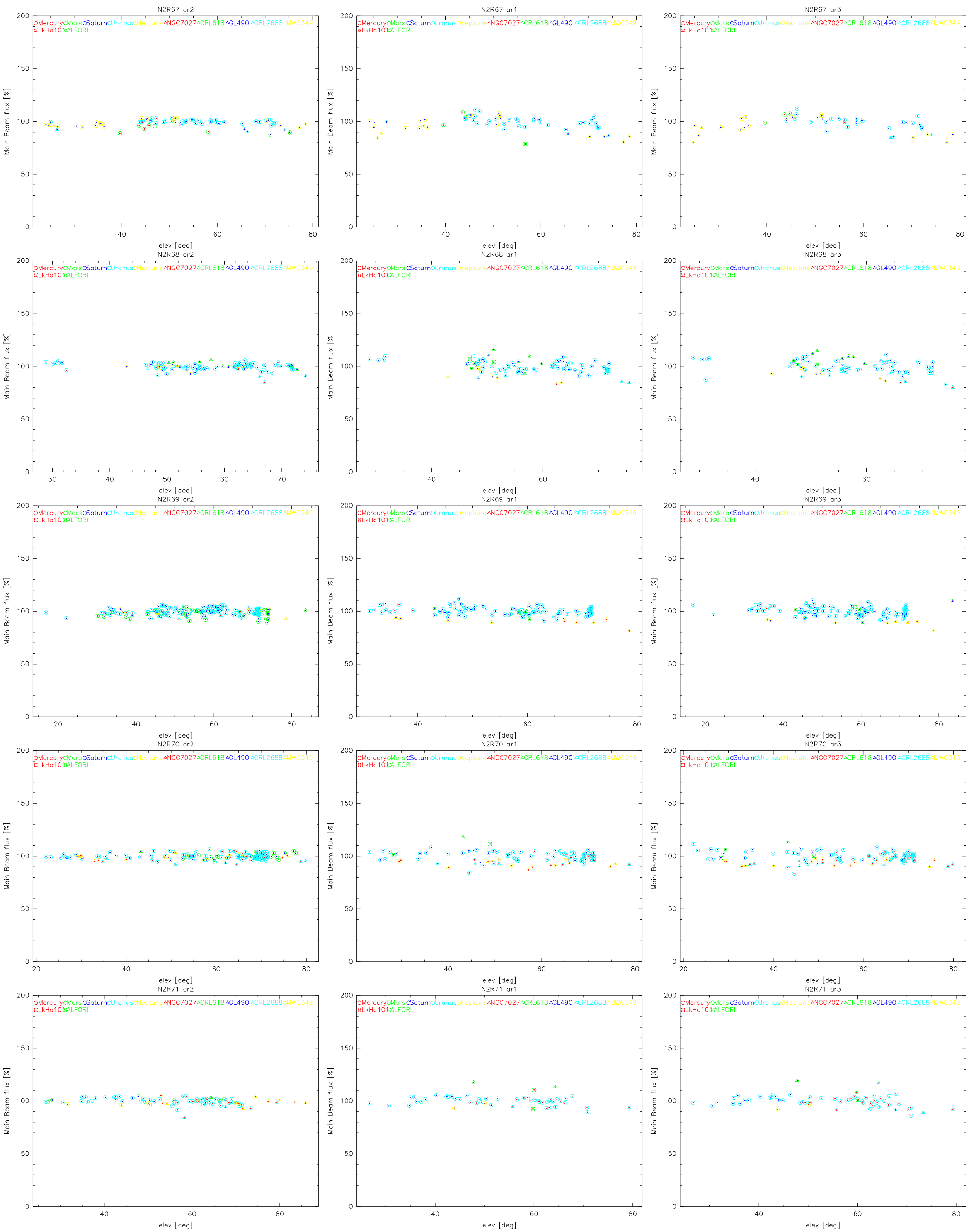

Figure 3: continued for runs 67, 68, 69, 70, 71.

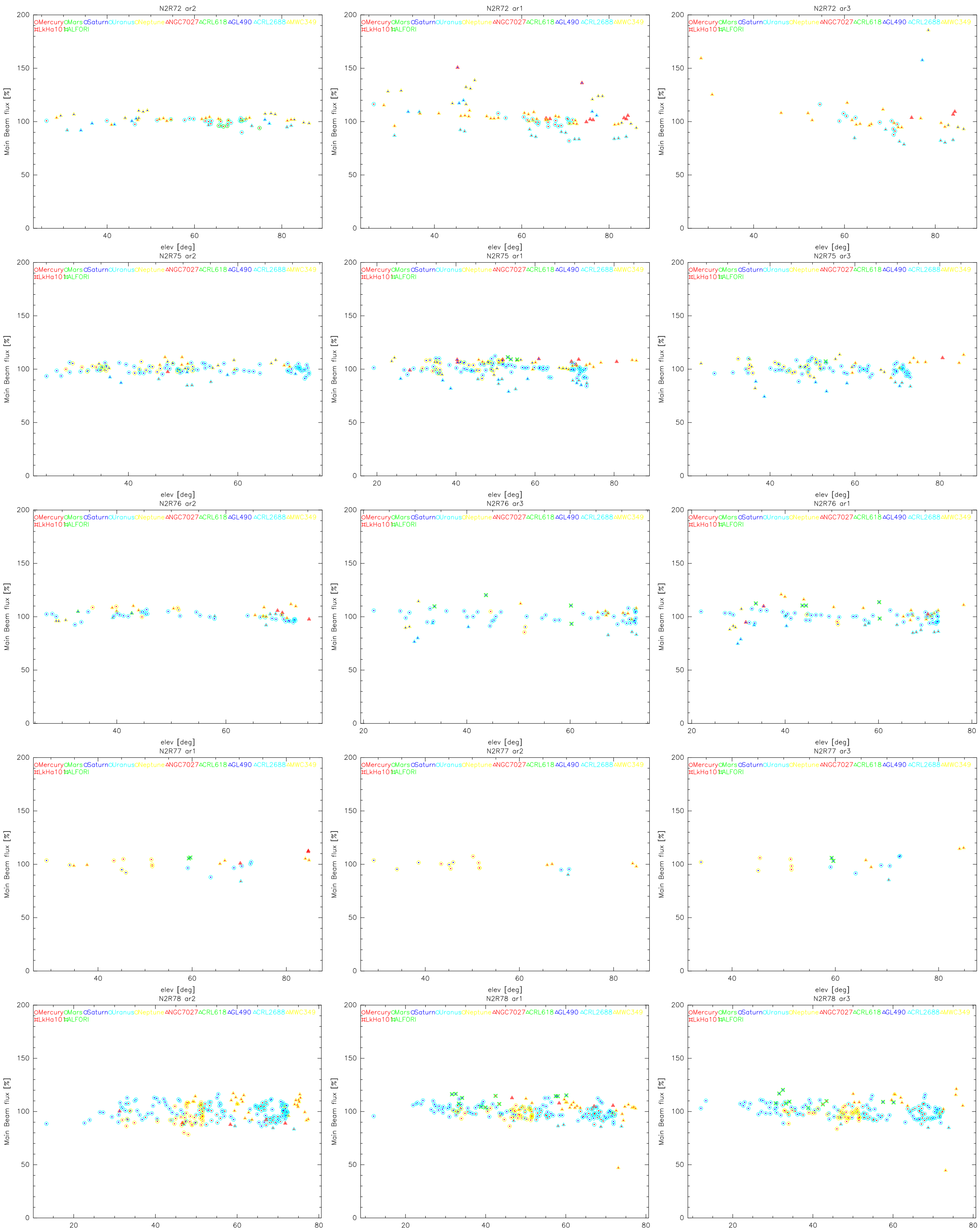

Figure 3: continued for runs 72, 75, 76, 77, 78.

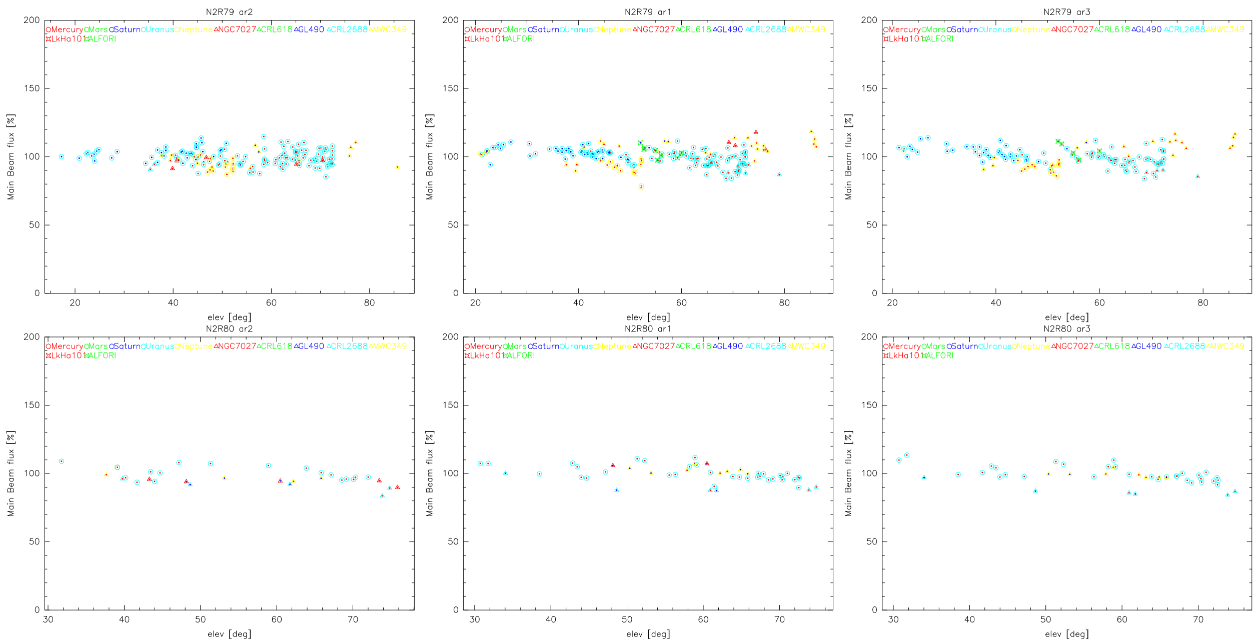

Figure 3: continued for runs 79, 80.

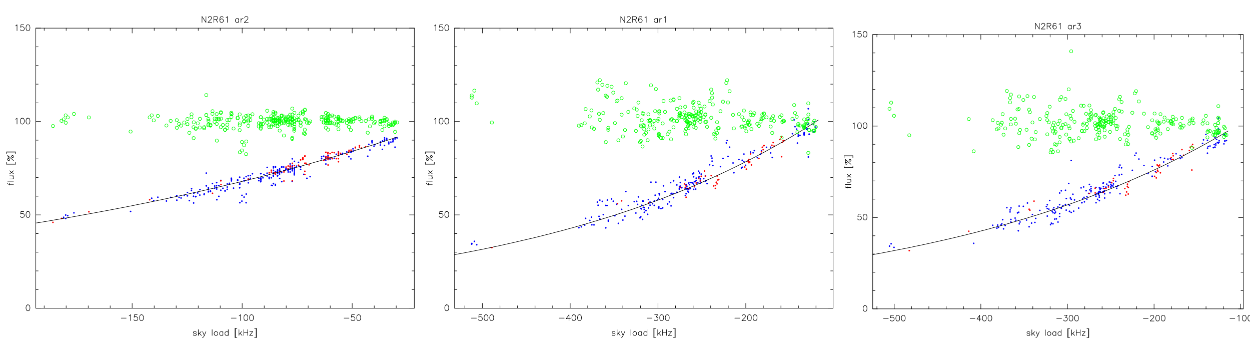

Figure 4: Example of fit of the dependence of extinguished flux on sky load and correction based on the fitted function. The red and blue dots represent the extinguished flux fraction recovered and the green dots are the corrected fluxes. The solid line represents the fitted function, used to correct the data.

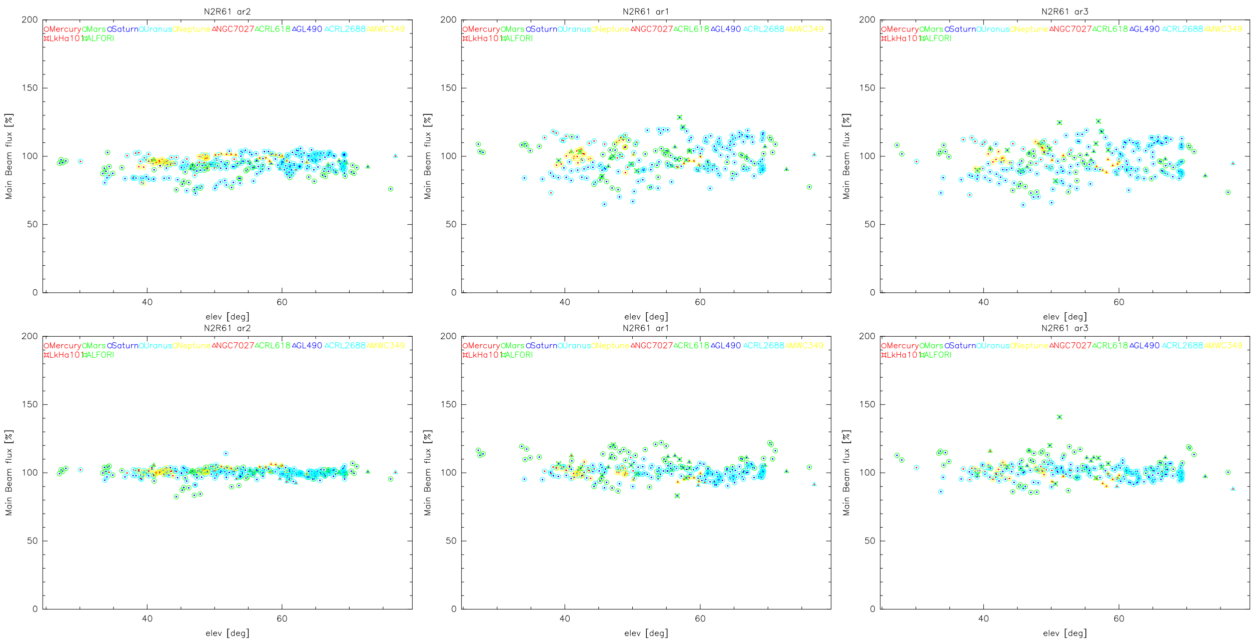

Figure 5: Comparison of the calibration performance using only the tau-meter measurement of sky opacity (*top*) and the sky load of the given scan to estimate the opacity along the actual line-of-sight (*bottom*). The example of the NIKA2 run 61 is shown.

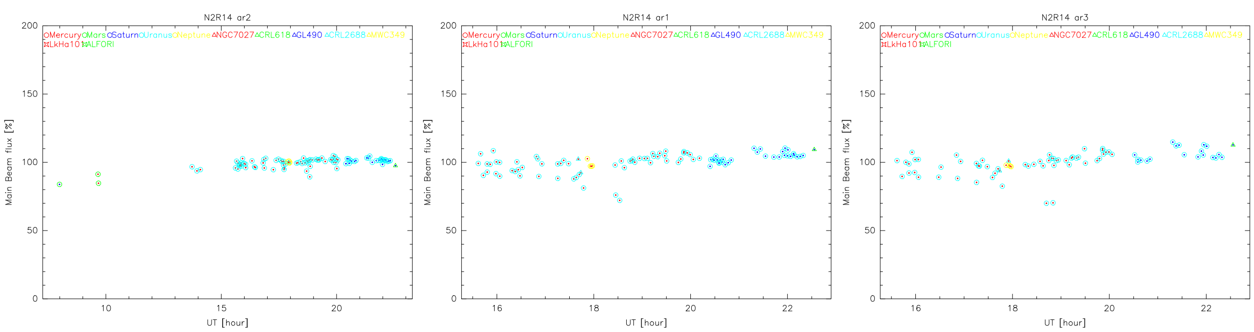

Figure 6: Main beam flux percentage (of intrinsic flux) as a function of UT, for NIKA2 run 14. Different calibrators are depicted with different symbols/colors. Red and blue dots mark scans taken during day- and night-time, respectively. A clear difference of r.m.s. and possibly flux level between day and night is visible.