

Double Star Measurements with a 12-inch Newtonian Telescope, Annual Report of 2022

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Abstract

This report shows the results of 323 double star measurements from 2022. During the observations some new components of known double stars and 6 new double stars could be found.

1. Introduction

In 2022 323 double stars were measured. As in previous years, pairs with large magnitude differences were of interest. Especially the double stars discovered by the British astronomer Espin were chosen for observation. An short overview about Espin's double stars can be found in the author's annual report from 2021 (Schlimmer 2022). During the observations some new components from known double stars and 6 new double stars were discovered and will be discussed.

2. Equipment and Methods

Observations were done with a 12-inch Newtonian telescope in combination with a QHY5L II CMOS color camera. Focal length is 1500 mm, reproduction scale is about 0.52 arc seconds per pixel. In cases of separation $< 3''$ focal length were sometimes magnified with a Barlow lens. Calibration of the telescope setup was described in detail in the previous annual report of 2021 (Schlimmer, 2022).

For each measurement a video with 100 or 200 frames were recorded. Every frame is like a single measurement. Data analyses were done with REDUC software (Losse, 2016). For each frame separation and position angle will be automatically analyzed by the ELI interface. The standard deviation for measurements of the separation is usually smaller than ± 0.15 arc seconds. The standard deviation for measurements of position angle depends on the separation of both components. For double stars with separation of about 5 arc seconds the standard deviation for position angle is usually ± 1 degree.

3. Discoveries

During the observations some new components and 6 new double stars could be found which aren't listed in the WDS catalog. The nature of those isn't known. In the case where proper motion of both components is known but different it can be assumed that they are optical double stars.

3.1 New component of WDS04582+3503, BU 1390, (98 Tau)

BU 1390 AB was discovered by Burnham in 1912. AC was already discovered in 1891 by him, but there is no registration about his observations of 98 Tau in his famous *General Catalogue of 1290 double stars discovered from 1871 to 1899* (Burnham, 1900). During the author's observation of BU 1390 a new component next to the primary could be found. Compared with the brightness of component B the brightness of the new component can be estimated at 14 mag. Separation is $28.0''$, position angle is about 109° . Figure 1 shows a stacked image of 100 frames. Exposure time was 1s.

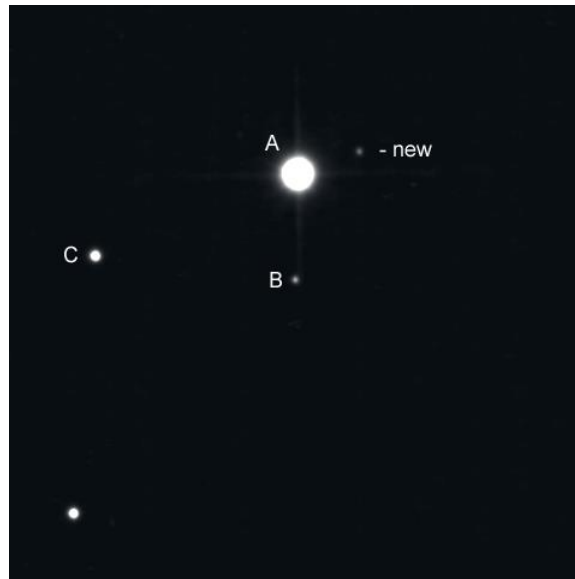


Figure 1 : 98 Tau, (BU 1390), stacked image of 100 frames. Exposure time was 1s.

3.2 A new double star TYC2085-280-1

In a distance of 216'' from ES 469 (WDS17467+2759) a new double star can be found. Identifier of the primary component is TYC2085-280-1, its brightness is 12.15 mag. A second component appears in 6.8'' at an angle of 341°. Its brightness is about 12.7 mag. Figure 2 shows the neighborhood of ES 469 and TYC2085-280-1 from SIMBAD catalog with inlay of stacked frames of TYC2085-280-1 made by the measurement. Coordinates are 17 46 23.8 +27 57 26.3. Its nature is uncertain.

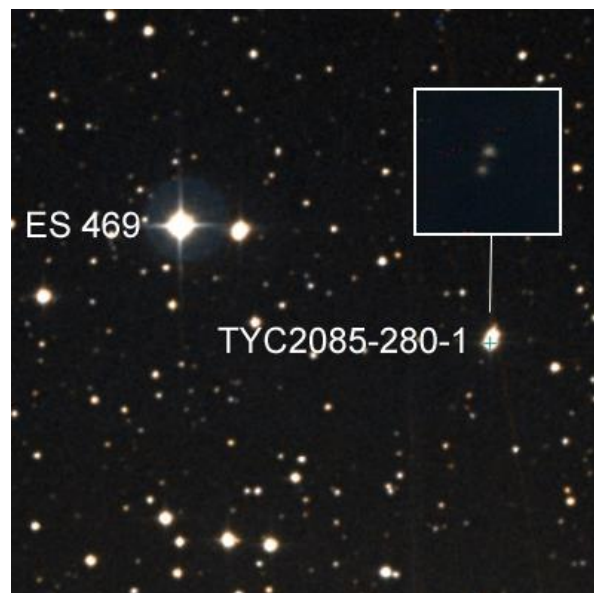


Figure 2 : ES 469 and TYC2085-280-1 from SIMBAD catalog with inlay of stacked frames of TYC2085-280-1 from observation

3.3 New optical double star TYC4209-01624-1 and TYC 4209-1724-1

In a distance of about 17' from 36 Dra an optical pair TYC4209-01624-1 / TYC 4209-1724-1 could be found. Brightness of TYC4209-01624-1 is 8.93 mag, proper motion is $-3.628 / -5.766$ mas/yr. Brightness of the secondary component is 11.44 mag, its proper motion is $-10.086 / -7.344$ mas/yr. Separation of both is $32.36''$, position angle is 263.8° . Coordinates of TYC4209-01624-1 are $18\ 15\ 26.4\ +64\ 09\ 35.1$. Because of different proper motions of both components there is no physical relationship between them.

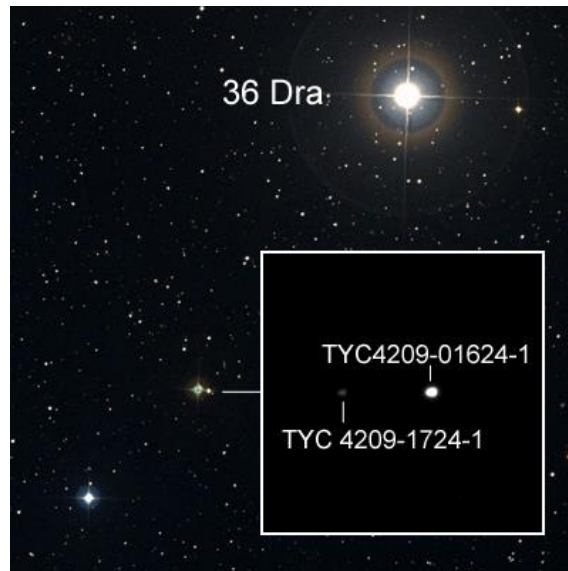


Figure 3 : TYC4209-01624-1 and TYC 4209-1724-18 from SIMBAD catalog with inlay of stacked frames from observation

3.4 New optical double star HD336458 and HD336459 next to WDS18349+2701, ES 477

Only $115''$ from ES 477 (WDS18349+2701) an nice optical pair with HD336458 and HD336459 can be found. Brightness are 10.34 and 10.69 mag, so they can be easily observed. Separation is $27.8''$ position angle is 252.4° . Proper motion of both components is very different, so it can be assumed that there is no physical relationship between them. Coordinates of HD336458 are $18\ 34\ 43.9\ +26\ 59\ 56.9$.



Figure 4 : ES 477 (WDS18349+2701) and HD336458 / HD336459. Image is stack of 100 frames

3.5 Three new components in WDS18569+3112, ES 2422

ES 2422 was discovered in 1930 by Espin. His 2 known components has a brightness of 8.96 and 12.00 mag and are in a distance of $5.7''$. During observation of ES 2422 the author found 3 further components. First one in a separation of $23.7''$ with a position angle of 249.6° . Brightness is about 13 mag. Second new component can be found in a distance of $31.9''$ with an angle of 317.2° . Brightness is about 12.5 mag. Third new component has more less the same brightness like component B. Separation is only $13.4''$, position angle is 321.2° .

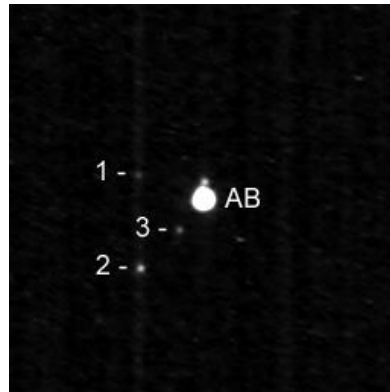


Figure 5 : ES 2422 with 3 new components, labeled by numbers. Image is stack of 100 frames.

3.6 A new triple star next to WDS23154+5516, STI2963

In a distance of $84''$ from STI2963 a new triple star system can be found. The brightness of component A with 12 mag is similar to the primary of STI2963, B has a brightness of about 13 mag. Separation between both is $7.9''$ position angle is 345.8° . In a distance of $18.8''$ at an angle of 303.4° component C can be found. Brightness is about 14 mag. The nature of the triple star system is uncertain.

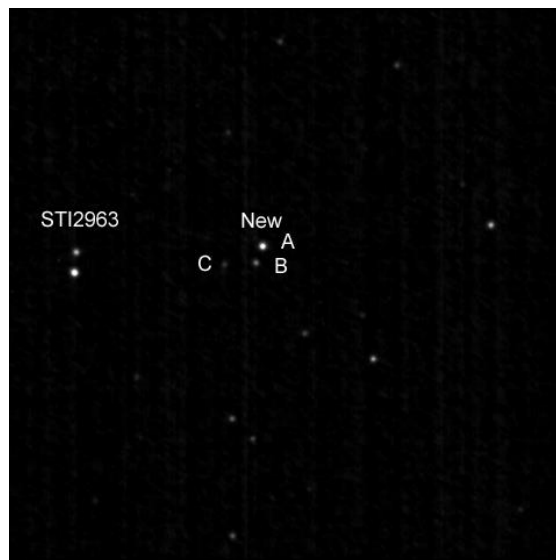


Figure 6 : New triple star system next to STI2963

3.7 New double star HD 23616 next to ES 1044, WDS23271+5302

In a distance of 160'' from ES 1044 a new double star can be found. Primary is HD 23616 which has a brightness of 10.23 mag, secondary is a not identified star in a distance of 12.25''. Position angle is 164.5°. Brightness of the secondary is 12.2 mag. Coordinates of HD 23616 are 23 27 28.8 +53 03 48.0. The nature of this double star is uncertain.

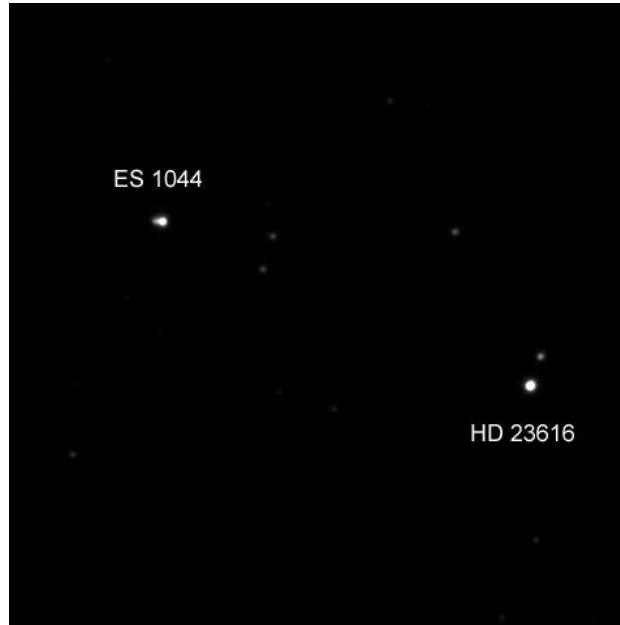


Figure 7 : ES 1044 and HD 23616 with companion.

3.8 A new double star USNO-B1 1422-0565068 and USNO-B1 1421-0552384

About 4' from WDS 23361+5211 (TDT4121) a new double star can be found. With a brightness of 11.4 mag USNO-B1 1422-0565068 is the primary, while USNO-B1 1421-0552384 in 3.95'' is the secondary with a brightness of 12.3 mag. Position angle is 14.4°. Proper motion of the primary is -10 in RA and -4 mas in DE, proper motion of the secondary isn't known. The new double star can be found at 23 35 39.9 in RA and +52 12 11.8 in DE. The nature of this double star is uncertain.

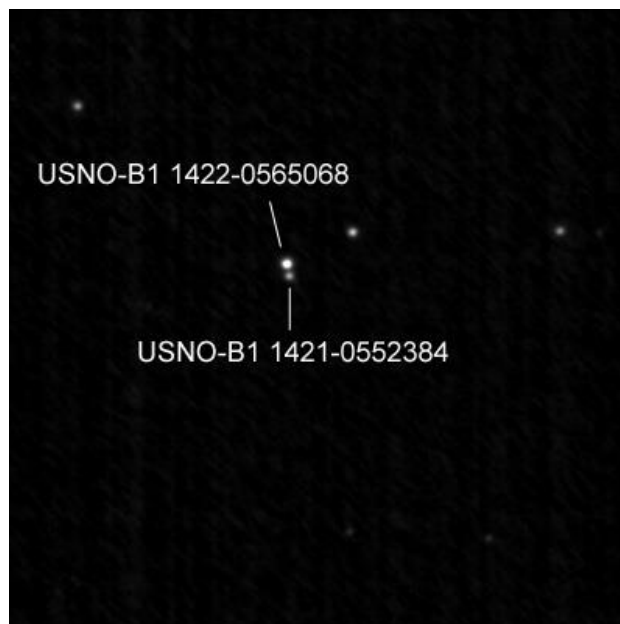


Figure 8 : USNO-B1 1422-0565068 and USNO-B1 1421-0552384

4. Observation Data

The following table shows the measurements of separation and position angle of 323 double stars from 2022. Brightness and coordinates are taken from *The Washington Double Star Catalog* (Mason et al., 2020). Date is given in Julian years. N gives the numbers of observation nights. Usually, every double star will be observed only for one night (N=1).

Table 1: Measurements of 2022

RA+DEC	Name	MAGS	PA	SEP	Date	N	Notes
03001+4323	ES 1511	10.5,11.7	281.3	6.72	2022.120	1	
03119+4146	ES 1513	10.58,11.7	92.7	7.40	2022.120	1	
03164+5050	ES 769	10.23,12.1	139.1	5.42	2022.120	1	
04010+3415	ES 237	9.82,11.17	331.0	3.09	2022.120	1	
04026+5304	ES 1066	10.9,11.1	115.1	5.65	2022.120	1	
04075+6009	ES 1715	8.73,10.6	165.1	5.86	2022.120	1	
04078+6220	ES 2603AB	6.91,12.9	255.3	6.41	2022.120	1	NGC1502
04078+6220	STF 485AC	6.91,13.5	0.8	11.18	2022.120	1	NGC1502
04078+6220	STF 485AE	6.91,6.94	305.2	17.91	2022.120	1	NGC1502
04078+6220	STF 484GH	9.63,10.5	133.4	5.55	2022.120	1	NGC1502
04078+6220	HLM 3LM	10.4,11.4	216.6	5.99	2022.120	1	NGC1502
04078+6220	HZG 2OP	9.49,10.69	229.2	17.37	2022.120	1	NGC1502
04089+6231	ES 1882	9.33,12.4	278.2	7.31	2022.120	1	
04091+4801	ES 1223	10.21,12.1	112.3	3.73	2022.120	1	
04477+4744	ES 1318	10.2,11.3	156.7	2.21	2022.167	1	
04537+4737	ES 1227	9.86,11.3	239.2	4.12	2022.162	1	
04582+2503	BU 1390AB	5.81,13.3	357.7	45.28	2022.162	3	
04582+2503	NEW	5.81/14	109.3	28.00	2022.162	2	See section 3.1
05020+4349	BU 554AB	2.99,14.0	226.2	29.33	2022.222	1	Eps Aur
05020+4349	BU 554AC	2.99,11.26	276.0	43.17	2022.222	1	
05020+4349	BU 554AD	2.99,13.4	317.5	44.92	2022.222	1	
05020+4349	SMR 25AG	2.99,14.	15.2	99.52	2022.222	1	
05020+4349	SMR 25AI	2.99,13.5	140.9	111.86	2022.222	1	
05020+4349	SMR 25AJ	2.99,13.5	159.9	132.44	2022.222	1	
05039+3223	ES 412	8.3,13.1	275.0	5.13	2022.162	1	
05046+4232	ES 1621	9.92,12.3	193.4	4.13	2022.162	1	
05058+3540	ES 331	9.27,11.7	326.8	8.05	2022.167	1	
05132+4429	ES 1373AB	9.50,10.6	85.9	5.61	2022.167	1	
05143+6127	ES 1963	9.09,12.8	269.7	3.59	2022.162	1	
05144+5424	ES 889	10.0,11.4	319.3	7.91	2022.167	1	
05145-0812	STF 668A,BC	0.3,6.8	202.8	9.46	2022.136	1	Rigel
05167+4600	HJ 2256AF	0.08,10.21	134.2	104.72	2022.222	1	
05173+5335	ES 2610	9.51,10.13	52.4	45.00	2022.167	1	
05212+5023	ES 2613	9.38,10.1	123.6	8.81	2022.167	1	

05247+3723	BU 888AB	5.16,12.0	163.4	7.47	2022.162	1	
05272+1758	STT 107AB	5.39,11.1	306.8	10.13	2022.162	2	
05274+5422	ES 891	9.40,12.6	67.3	6.90	2022.167	1	
05280+4110	ES 1724	10.67,12.9	48.4	2.90	2022.167	1	
05314+4152	ES 1625	10.6,11.6	80.3	3.14	2022.181	1	
05316+3843	ES 2216	11.4,11.6	125.8	3.35	2022.181	1	
05320-0018	STFA 14AC	2.41,6.83	0.7	52.46	2022.110	1	
05323+4924	STF 718AB	7.47,7.54	72.2	7.78	2022.181	1	
05329+4912	ES 1072	10.3,11.4	0.28	3.39	2022.181	1	
05332+6212	ES 1887	9.28,10.4	106.3	5.37	2022.181	1	
05365+3903	ES 2152	10.31,11.8	312.6	7.16	2022.181	1	
05407-0157	STF 774AB	1.88,3.70	168.3	2.07	2022.110	1	
05407-0157	STF 774AC	1.88,9.55	10.2	58.18	2022.110	1	
05424+3831	ES 2217	10.30,10.55	131.0	3.97	2022.181	1	
05469+0931	J 251	5.79,11.9	304.8	16.67	2022.162	1	
05515+3909	H 5 90	3.97,11.40	206.5	55.56	2022.222	1	
05533+3725	ES 284	10.4,12.4	182.9	4.67	2022.222	1	
05574+0002	BU 1190AC	6.95,12.1	100.9	6.58	2022.162	1	
05597+3713	STT 545AB	2.60,7.2	301.6	3.705	2022.222	1	
06039+4754	ES 1233	9.2,11.0	208.7	2.94	2022.222	1	
06148+1909	HJ 2302AB	5.20,11.2	179.0	5.64	2022.162	2	
06288-0702	STF 919AB	4.62,5.00	132.1	7.34	2022.181	1	
06288-0702	STF 919AC	4.62,5.39	126.8	9.54	2022.181	1	
06288-0702	STF 919BC	5.00,5.32	107.0	2.63	2022.181	1	
06367+4404	ES 582AB	11.29,11.66	79.3	23.92	2022.222	1	
06367+4404	ES 582BC	11.66,14.4	301.8	6.60	2022.222	1	
06410+0954	STF 950AC	4.66,9.9	14.4	16.60	2022.181	2	AB,C
06410+0954	D 11EP	8.86,10.4	46.0	3.88	2022.181	2	
06425+3902	SIN 119AC	8.34,11.3	28.9	15.41	2022.222	1	
06451-1643	AGC 1AB	-1.47,8.44	64.8	11.27	2022.175	8	Sirius
06505+5327	ES 899	10.0,11.2	314.5	2.90	2022.222	1	
07277+2208	ES 2625AB	6.98,12.4	26.4	11.63	2022.222	1	
07303+4136	ES 586	8.26,11.2	23.1	13.45	2022.222	1	
08358+0637	STF1245AB	5.98,7.16	24.9	10.09	2022.235	1	
08397+0546	STF1255AB	7.33,8.56	30.5	25.93	2022.235	1	
08468+0625	STF1273AB,C	3.49,6.66	313.8	2.78	2022.235	1	
08484+0550	AGC 3	4.36,11.9	146.8	12.20	2022.235	1	
08534+0513	A 2752	8.99,11.01	229.6	5.11	2022.235	1	
09036+4903	ES 72	9.29,12.3	301.0	13.33	2022.402	1	
09098+5340	ES 715	10.36,11.7	232.5	7.77	2022.402	2	
09144+0219	HJ 2489AB	3.85,9.9	255.8	20.64	2022.235	1	
09188+3648	STF1334AB	3.92,6.09	222.0	2.54	2022.416	1	3000mm
09234+5136	ES 718AB	10.16,12.5	28.1	7.86	2022.402	1	
09257+3837	ES 298AB	9.99,12.4	319.8	8.42	2022.402	1	
09257+3837	ES 298AC	9.99,11.09	320.8	93.61	2022.402	1	
09257+3837	ES 298CD	11.09,12.1	173.9	3.80	2022.402	1	
09368+5755	ES 1783AB	10.04,10.75	240.8	120.54	2022.402	1	

09368+5755	ES 1783Ba,Bb	11.1,11.9	9.0	2.02	2022.402	1	
09412+0954	H 6 76AB	3.56,10.83	48.9	97.79	2022.345	1	
09447+3218	ES 2347	10.72,11.0	251.4	7.95	2022.402	1	
09504+4245	ES 1244	10.24,11.07	242.1	2.06	2022.416	1	3000mm
09538+4658	ES 913	10.2,11.3	337.3	7.62	2022.402	1	
10009+4631	ES 914	10.46,12.8	327.3	5.85	2022.345	1	
10050+4634	ES 1149	9.33,12.7	249.6	7.98	2022.345	1	
10084+1158	STFB 6AB	1.40,8.24	308.1	176.51	2022.345	1	
10185+3630	HJ 2525	11.80,12.00	67.4	13.60	2022.345	1	
10258+3237	ES 432	11.06,11.62	165.7	2.64	2022.402	1	
10262+3628	ES 302	11.22,12.7	345.9	2.66	2022.345	1	
10303+6321	ES 1905AB	8.59,12.64	67.0	41.2	2022.345	1	
10443+3739	ES 2634	10.90,11.52	234.4	9.44	2022.402	1	
10479+3958	ES 1543	10.0,12.5	7.9	3.34	2022.416	1	
10532+4359	ES 2635AB	9.54,10.3	34.5	9.62	2022.416	1	
10562+4802	ES 2636	8.90,9.62	149.4	42.68	2022.416	1	
10590+3256	ES 2283AB	11.13,12.62	106.9	5.64	2022.416	1	
11141+2031	STT 573AB	2.54,10.87	341.6	208.60	2022.345	1	
11141+2031	BU 1282AC	2.54,12.69	28.6	98.96	2022.345	1	
11323+3323	ES 2284	11.0,11.1	76.2	2.94	2022.416	1	
11381+3246	ES 2285AB	11.01,12.39	331.2	10.78	2022.416	1	
11491+1434	BU 604AD	2.14,8.49	193.7	235.82	2022.345	1	
12081+5528	STF1603AB	7.82,8.26	83.5	22.22	2022.424	1	
12104+5455	ES 73AB	9.05,11.6	29.7	37.77	2022.424	1	
12104+5455	ES 73BC	11.6,12.1	306.9	3.06	2022.424	1	
12269+2816	SMR 58	4.4,12.	205.6	15.77	2022.402	1	
12280+4753	ES 2642	10.15,10.41	258.0	28.22	2022.424	1	
12347+4808	ES 924	11.07,11.72	219.4	4.17	2022.424	1	
12353+3634	ES 2166	12.4,12.7	357.9	4.78	2022.424	1	
12397+4028	ES 1402AB	10.6,11.6	27.1	3.78	2022.424	2	
12406+4017	HJ 2617AB	8.41,9.61	1.4	5.69	2022.424	1	
12417-0127	STF1670AB	3.48,3.53	356.2	3.15	2022.408	3	3000mm
12439+5349	ES 729	9.1,12.6	226.9	8.81	2022.424	1	
13119+2753	STT 578	4.30,12.1	178.6	134.67	2022.402	1	
13149+4847	PKO 10	12.00,11.90	269.7	20.38	2022.444	1	
13152+4838	ES 732	10.93,10.98	88.2	3.39	2022.444	1	
13239+5456	STF1744AB	2.23,3.88	152.9	14.41	2022.424	1	
13265+4233	ES 2645	10.99,11.10	210.9	21.94	2022.444	1	
13486+4821	BU 802	7.56,11.78	221.1	3.25	2022.444	1	
13529+4744	ES 960AB	10.7,11.9	270.4	4.43	2022.444	1	
14375+4743	ES 609AB	10.23,11.9	15.2	4.51	2022.444	1	
14375+4743	ES 609AC	10.23,10.22	117.9	78.64	2022.444	1	
14380+5135	STF1863	7.71,7.80	57.6	0.63	2022.405	1	
14439+4743	ES 962AB	8.7,11.3	267.2	11.44	2022.444	1	
14573+4806	ES 2647	9.44,12.4	118.5	9.06	2022.444	1	
15054+4809	BU 1086	5.57,13.3	252.2	6.49	2022.444	1	
15127+4835	ES 2648AB	7.28,11.25	340.7	26.24	2022.444	1	

15135+3244	ES 2476	10.5,11.5	212.7	2.56	2022.444	1	
15151+3318	SMR 32AB	12.76,11.21	337.5	27.80	2022.444	1	
15151+3318	SMR 32AC	12.76,12.90	70.2	37.51	2022.444	1	
15151+3318	SMR 32BC	11.21,12.90	105.8	47.69	2022.444	1	
15185+5159	BEM 18	10.3,12.0	13.5	8.68	2022.454	1	
15198+5245	ES 741AB	9.78,11.8	233.6	8.91	2022.454	1	
15200+4603	ES 75AB,C	11.02,10.74	35.7	4.42	2022.454	1	
15222+4508	ES 2649	9.55,10.14	5.2	25.75	2022.454	1	
15351+4150	ES 1553	11.40,11.78	151.6	2.69	2022.454	1	
15409+5009	ES 626	9.2,9.2	275.6	8.17	2022.454	1	
16003+5856	STF2006AB	8.48,9.96	180.3	1.50	2022.539	1	3000mm
16010+4338	ES 1556	9.5,11.2	235.3	11.05	2022.487	3	
16042+5923	ES 2650	8.56,10.0	209.1	10.83	2022.505	3	
16051+5426	ES 743	9.71,12.8	11.9	5.45	2022.507	1	
16090+5756	ES 2651	6.33,12.14	139.4	12.38	2022.501	1	
16126+5748	ES 1793	8.74,11.52	56.8	5.62	2022.501	1	
16186+5120	ES 627	9.88,10.98	287.2	11.86	2022.501	1	
16232+6017	ES 1827	10.2,12.1	36.4	4.92	2022.501	1	
16356+5633	ES 2652	11.00,11.12	180.8	13.34	2022.501	1	
16362+5255	STF2078AB	5.38,6.42	103.5	2.99	2022.539	1	
16379+5608	A 1140	8.61,11.7	117.8	3.29	2022.501	1	
16408+5014	ES 632	11.27,11.70	107.9	1.64	2022.537	1	
16426+2340	STF2087AB	8.84,8.90	287.7	5.24	2022.539	1	3000mm
16440+5036	ES 76AB	10.77,11.27	43.0	2.20	2022.519	2	
16440+5036	ES 76AC	10.77,11.07	204.6	44.28	2022.519	2	
16442+2331	STF2094AB	7.48,7.87	75.0	1.03	2022.539	1	3000mm
16454+5027	ES 2653	10.48,12.0	289.5	10.85	2022.501	1	
16461+5012	ES 969	11.01,11.45	237.5	2.57	2022.537	1	
16465+4759	ES 1089AB	10.66,11.7	150.5	12.55	2022.522	2	
16465+4759	ES 1089AC	10.66,12.73	29.8	32.63	2022.522	2	
16465+4759	CTT 20DE	10.75,12.49	126.3	27.40	2022.507	1	
16465+4759	CTT 20EF	12.49,12.72	33.9	34.65	2022.507	1	
16518+5103	ES 971AB	10.53,12.21	43.42	46.31	2022.522	2	
16555+5141	ES 972	11.64,11.93	104.1	2.08	2022.537	1	
16566+5127	ES 2654	9.21,9.83	282.5	37.03	2022.537	1	
16566+4505	ES 2655	9.72,9.92	67.2	47.70	2022.543	2	
17053+5428	STF2130AB	5.66,5.69	356.9	2.68	2022.539	1	3000mm
17131+5408	STF2146AB	8.71,10.56	223.5	2.50	2022.539	1	3000mm
17146+1423	STF2140AB	3.48,5.40	103.5	4.86	2022.602	1	a Her
17161+5854	ES 1794	11.00,11.22	139.4	4.02	2022.543	2	
17195+5832	KR 46	9.34,9.60	63.5	1.58	2022.537	1	3000mm
17220+5638	ES 2657AB	8.60,11.2	96.4	27.9	2022.548	1	
17220+5638	ES 2657BC	11.2,11.5	72.9	11.51	2022.548	1	
17245+4327	ES 1413	10.34,12.9	240.5	7.70	2022.548	1	
17270+5718	ES 2658	9.98,12.1	15.7	9.83	2022.548	1	
17319+5655	ES 2659	8.63,11.15	215.0	11.69	2022.561	1	
17374+5040	ES 2661AB	8.46,9.84	102.6	58.52	2022.561	1	

17374+5040	ES 2661BC	9.84,12.8	17.5	14.94	2022.561	1	
17386+5546	STF2199	8.03,8.60	52.3	2.02	2022.539	1	3000mm
17444+4027	ES 9004	8.10,12.7	248.2	13.29	2022.561	1	
17467+2759	ES 469AB	9.03,11.79	267.3	47.14	2022.548	1	
17467+2759	ES 469BC	11.79,14.8	149.0	3.72	2022.548	1	
17464+2757	NEW	12.15,12.7	341.4	6.80	2022.548	1	See section 3.2
17484+4941	ES 1092	11.40,11.8	21.9	3.65	2022.561	1	
17496+3649	ES 2169	11.40,11.7	337.4	8.54	2022.548	1	
17536+6103	ES 1833	7.95,12.6	261.4	8.14	2022.561	1	
17555+4108	ES 1557AB	9.08,12.4	12.8	11.75	2022.548	1	
17555+4108	ES 1557AC	9.08,12.29	216.0	27.00	2022.548	1	
17555+4108	ES 1557AD	9.08,13.35	313.7	40.22	2022.548	1	
17566+3110	ES 343	9.74,12.4	284.6	8.28	2022.548	1	
17573+3351	ES 344	9.7,10.2	31.6	9.06	2022.548	1	
17574+5111	ES 78AB	9.44,12.38	130.3	7.88	2022.548	1	
18003+4548	ES 1260	10.63,11.7	201.6	2.77	2022.561	2	
18011+4521	STF3129	7.59,10.64	167.7	30.82	2022.561	1	
18015+4517	STF2270	10.95,11.1	211.7	6.26	2022.561	1	
18025+3643	ES 2479	10.65,12.7	232.0	9.92	2022.561	1	
18033+2751	ES 470	9.45,10.7	209.7	8.11	2022.600	1	
18047+2750	SLE 109	10.72,13.7	79.6	9.76	2022.600	1	
18047+2707	ES 471AC	7.21,10.2	44.9	23.92	2022.600	1	
18047+2707	SLE 106AD	7.21,11.03	244.9	88.83	2022.600	1	
18047+2707	SLE 106AE	7.21,10.84	43.1	183.62	2022.600	1	
18048+5435	ES 641	11.0,11.2	65.4	1.94	2022.600	1	3000mm
18069+4647	ES 1157AB	8.42,11.29	179.6	30.6	2022.600	1	
18069+4647	ES 1157AD	8.36,11.65	237.2	50.43	2022.600	1	
18069+4647	ES 1157BC	11.29,12.0	11.7	2.55	2022.600	1	
18077+3904	ES 2018	10.13,11.15	235.1	5.76	2022.600	1	
18080+3642	ES 183	9.36,12.7	168.6	8.33	2022.600	1	
18089+3254	ES 184AB	9.7,11.9	160.4	4.96	2022.600	1	
18107+3903	ES 2569	9.5,10.0	275.3	9.97	2022.602	1	
18111+3258	ES 185	9.89,10.99	283.6	12.79	2022.600	1	
18127+5557	ES 643	10.71,12.9	49.3	3.53	2022.613	1	
18138+6235	ES 1836	10.65,12.5	151.9	3.89	2022.602	1	
18138+5341	ES 645	8.94,12.7	84.7	2.96	2022.613	1	
18147+5635	BU 1274A,BC	6.37,10.91	237.2	93.98	2022.613	1	
18147+5635	BU 1274BD	9.8,10.4	4.9	5.41	2022.613	1	
181554+6410	NEW	8.93,11.44	263.8	32.36	2022.600	1	See section 3.3
18156+4417	ES 1420AB	10.22,11.4	67.2	8.38	2022.613	1	
18156+4417	ES 1420AC	10.22,14.5	10.6	14.42	2022.613	1	
18157+3723	ES 2664	10.57,10.78	84.0	9.23	2022.655	2	
18162+6404	ES 186	8.23,12.0	329.0	7.95	2022.600	2	
18162+4423	ES 1421	8.70,11.86	344.7	12.12	2022.655	2	
18197+4453	ES 2665AB	8.76,11.27	21.8	10.07	2022.698	1	
18210+3630	ES 2110	9.3,10.8	95.2	6.40	2022.698	1	
18218+6358	ES 1837	9.83,11.6	212.3	16.20	2022.698	1	

18259+6029	ES 2666	8.45,9.92	268.5	45.28	2022.698	1	
18269+4031	ES 1653	11.2,11.4	191.0	10.16	2022.698	1	
18280+2708	ES 475	9.74,10.7	221.6	10.20	2022.698	1	
18306+2805	ES 476AB	11.0,11.6	348.4	2.62	2022.723	1	
18306+2805	ES 476AC	11.0,12.0	324.3	28.34	2022.6723	1	
18325+4513	ES 1262	10.90,11.15	256.1	1.53	2022.747	1	3000 mm
18329+6343	STF2357	9.32,9.89	270.0	4.62	2022.735	2	
18337+3726	MLB 937	11.53,13.9	117.4	2.887	2022.723	1	
18339+3208	SLE 209	8.22,12.	29.1	10.31	2022.723	1	
18340+5058	ES 785AB	9.56,10.0	97.6	9.43	2022.723	1	
18340+5045	ES 786	11.33,11.6	322.0	5.82	2022.723	1	
18349+2701	ES 477	9.30,11.9	226.7	10.40	2022.747	1	
18347+2700	NEW	10.34,10.69	252.4	27.84	2022.735	2	See section 3.4
18369+3846	H 5 39AB	0.09,9.5	184.7	84.81	2022.582	2	Vega
18369+3846	STFB 9AE	0.09,9.5	38.5	84.21	2022.592	2	
18375+3112	A 250	9.39,10.61	115.2	2.39	2022.723	1	
18386+4700	ES 1159AB	9.8,11.5	252.0	3.75	2022.723	2	
18386+4700	ES 1159AC	9.8,11.1	346.2	19.70	2022.723	2	
18393+6348	ES 126AB	8.36,11.47	50.9	72.63	2022.723	1	
18393+6348	ES 126BC	11.47,12.34	22.4	4.78	2022.723	1	
18413+6311	ES 1839	10.5,12.5	12.8	4.21	2022.747	1	
18439+6039	ES 189AB	10.2,12.2	107.3	3.18	2022.747	1	
18443+3940	STF2382AB	5.15,6.10	341.1	2.05	2022.602	1	Eps Lyr,
18443+3940	STF2383CD	5.25,5.38	72.2	2.39	2022.602	1	
18466+3853	ES 2021AB	11.26,12.2	254.7	20.24	2022.747	1	
18466+3853	ES 2021BC	12.2,13.4	293.2	4.14	2022.747	1	
18473+6254	ES 127	11.12,11.30	143.8	4.94	2022.747	1	
18501+3322	STFA 39AB	3.63,6.69	147.5	45.79	2022.602	1	b Lyr
18501+3322	BU 293AE	3.63,10.14	316.5	67.38	2022.602	1	
18501+3322	BU 293AF	3.63,10.62	17.4	86.20	2022.602	1	
18508+4543	ES 1264	10.37,11.5	114.0	3.29	2022.764	1	
18516+3739	ES 2025AB	10.98,11.46	354.6	25.81	2022.764	1	
18516+3739	FYM 39AE	10.98,13.4	300.2	63.18	2022.764	1	
18516+3739	FYM 39AG	10.98,12.8	114.6	55.53	2022.764	1	
18516+3739	ES 2025BC	11.46,14.2	78.1	6.36	2022.764	1	
18516+3739	ES 2025BD	11.46,12.2	10.9	5.32	2022.764	1	
18520+3731	ES 2026AB	7.34,12.8	110.5	20.42	2022.764	1	
18520+3731	ES 2026BC	12.8,13.3	328.5	4.25	2022.764	1	
18523+3321	ES 2233AB	8.65,11.9	246.5	44.60	2022.764	1	
18523+3321	ES 2233BC	11.9,12.1	89.0	2.38	2022.764	1	
18545+3719	HO 90	8.72,12.7	226.9	3.69	2022.764	1	
18551+3645	ES 2485	11.0,11.5	164.0	5.20	2022.764	1	
18569+5723	ES 1747	10.26,10.58	350.3	1.59	2022.764	1	
18569+3112	ES 2422	8.96,12.0	179.8	5.66	2022.764	1	
18569+3112	ES 2422 AC	8.96,13	249.6	23.67	2022.764	1	see section 3.5
18569+3112	ES 2422 AD	8.96,12.5	317.2	31.85	2022.764	1	see section 3.5
18569+3112	ES 2422 AE	8.96,12	321.2	13.40	2022.764	1	see section 3.5

18580+6159	ES 1843	11.00,12.3	168.1	4.93	2022.764	1	
18593+6347	ES 1844AB	9.6,10.5	18.8	2.63	2022.764	1	
18598+5543	ES 1748	9.45,10.8	53.5	6.59	2022.764	1	
21069+3845	STF2758AB	5.20,6.05	153.9	32.04	2022.723	1	
21069+3845	STF2758AH	5.35,9.97	261.8	139.04	2022.723	1	
21069+3845	SMR 1AI	5.35,10.74	235.4	54.54	2022.723	1	
21069+3845	SMR 40AO	5.35,12.65	274.2	181.10	2022.723	1	
21069+3845	SMR 40AP	5.35,12.84	282.1	170.61	2022.723	1	
21069+3845	SMR 40AQ	5.35,13.19	291.9	78.86	2022.723	1	
23007+3105	STF2968	6.69,9.48	97.7	3.08	2022.947	1	
23045+3123	ES 396	10.84,10.91	303.6	37.66	2022.947	1	
23058+5006	ES 107AB	9.40,12.3	221.6	6.47	2022.947	1	
23058+5006	FOX9019AC	9.40,12.5	57.3	11.26	2022.947	1	
23105+5454	ES 1037	10.83,11.92	339.2	2.91	2022.947	1	
23153+5500	HJ 1861AB	10.12,12.0	258.7	18.44	2022.947	1	
23153+5500	HJ 1861BC	12.0,12.5	110.8	5.49	2022.947	1	
23154+5516	STI2963	12.06,12.8	183.2	9.10	2022.947	1	
23155+5516	NEW	12,13	345.8	7.87	2022.947	1	see section 3.6
23155+5516	NEW	12,14	303.4	18.79	2022.947	1	see section 3.6
23185+5409	ES 695AB	10.00,10.98	312.4	3.82	2022.947	1	
23187+5244	ES 1042	10.20,10.78	312.6	2.81	2022.947	1	
23192+5408	ES 696	9.78,12.4	232.5	2.90	2022.947	2	
23204+5530	ES 697AB	9.10,9.89	344.5	67.79	2022.947	1	
23204+5530	ES 697BC	9.89,13.4	71.0	4.59	2022.947	1	
23242+3753	ES 2002	10.6,11.1	101.1	4.02	2022.958	1	
23249+5430	ES 2728	9.79,10.17	247.3	10.11	2022.947	1	
23253+3528	ES 2136	10.3,12.0	355.6	3.64	2022.958	1	
23257+4800	ES 857	10.5,11.8	166.4	2.63	2022.958	1	
23266+5458	ES 1043AB	9.30,11.60	27.2	28.53	2022.947	1	
23266+5458	ES 1043AD	9.30,12.14	15.5	43.27	2022.947	1	
23266+5458	ES 1043BC	11.1,11.3	116.0	-	2022.947	1	
23271+5302	ES 1044	10.4,12.4	270.6	2.66	2022.953	1	
23273+5204	New	10.23,12.2	164.5	12.25	2022.953	1	see section 3.7
23293+2949	ES 400	10.83,11.4	210.5	6.01	2022.958	1	
23370+3456	ES 2208	10.8,11.0	86.5	2.61	2022.947	1	
23380+5249	ES 2729	8.08,9.53	142.0	19.80	2022.958	1	
23354+5212	NEW	11.4,12.3	14.4	3.95	2022.958	1	see section 3.8
23432+5455	ES 1048AB	10.87,12.57	249.4	14.61	2022.958	1	
23432+5455	ES 1048AC	10.87,11.57	283.0	16.42	2022.958	1	
23432+5455	ES 1048AD	10.87,10.84	14.8	70.42	2022.958	1	
23432+5455	ES 1048DE	10.84,10.9	322.9	4.60	2022.958	1	
23460+6013	ES 1767	10.85,12.9	38.3	5.56	2022.947	1	
23461+6028	STF3037AB	7.35,9.20	214.1	2.26	2022.947	1	
23465+5443	STI3032	11.94,12.9	220.7	10.62	2022.958	1	
23481+5947	ES 2733	9.89,11.1	84.6	9.05	2022.947	1	
23481+4106	ES 2734	8.35,10.08	222.8	28.67	2022.947	1	
23503+5114	ES 1124	10.38,10.87	247.5	2.75	2022.958	1	

23537+5453	ES 1050AB	9.73,12.6	228.2	3.60	2022.958	1
23537+5453	ES 1050AC	9.73,10.46	309.6	39.95	2022.958	1
23544+5139	ES 1125	10.87,11.14	331.6	4.44	2022.958	1
23546+5141	DAM 257	11.4,15.	325.3	8.33	2022.958	1
23583+5002	ES 927	10.42,12.9	190	6.10	2022.958	1
23596+5359	ES 703AB	8.40,12.0	269.8	7.35	2022.958	2
23596+5359	ES 703AC	8.40,11.32	265.2	50.75	2022.958	2

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