

On monitoring the re-entry of the ISS fragment by Russian Space Surveillance System

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At the 27th session of Interagency Coordination Space Debris Committee in Darmstadt in March 2009, a presentation was made on tracking the International Space Station (ISS) fragment at its initial lifetime period. Here its last lifetime period (including its re-entry) is presented as well.

During the 126th mission of Space Shuttle to the ISS on November 18, 2008 American cosmonauts Heidemary M. Stefanishyn-Piper and Stephen Gerard Bowen went out into space. They remained there for 6 hours and 52 minutes. The main task outside the station was technical service (namely lubrication) of the solar panels' rotation gears. About 11.33 p.m. Moscow time (2 and a half hour after leaving the station) Stefanishyn-Piper reported that one of the lubricant-spraying pistols had lost its hermetic property and its lubricant had gone into the spacewalker tool bag. She extracted the tool bag out of the container and began to clean the rest of the tools. But one of her jerks appeared to be too sharp, and the tool bag broke away from her hands and escaped the station vicinity.

According to experts of NASA and Russian TSUP (Space Operation Center) that was the largest and most massive loss in all history of getting out into space.

The exact size and mass of the spacewalker tool bag were not published to our knowledge. According to available information the lost item was a universal bag for works in space. The tool bag had a semi-rigid construction of a carbon metal-finished white fabric. Approximate size was 50×40×30 (cm). The content of the tool bag was announced as 2 lubricant-spraying pistols, some scrapers, ropes, and napkins. Although according to some information there were some more articles there, for example a heat-proof steel item – perhaps a gas-cylinder for providing the proper pressure in the lubricating tools.

Russian Space Surveillance System (RSSS) detected and then cataloged the spacewalker tool bag as an ISS fragment having the international designator 19980670059 on November 21, 2008. The first cataloged orbit was calculated by 10 measurements from the Crimea observatory (Table 1).

Table 1. Orbit parameters

Date, time	T, min	i, deg	Ω , deg	ω , deg	e	Kb	h_a	h_p	ΔT , min/rev
21.11.2008 00:34:08 GMT	91.82	51.68	292.42	43.2	0.00280	+0.010	377	339	-0.000368

Since November 22, 2008 and through its decay (end-of-life) the radar sensors of RSSS in Siberia, Kazakhstan, Ukraine, and Moscow region had been steadily tracking the fragment. The average rate of measurements entry to the Space Surveillance Center was some 2 – 4 radar measurements a day and 5 – 8 optical measurements a day.

On January 13, 2009 the orbit was as in Table 2.

Table2. Orbit parameters

Date, time	T, min	i, deg	Ω , deg	ω , deg	e	Kb	h_a	h_p	ΔT , min/rev
13.01.2009 22:23:06 GMT	91.26	51.62	15.50	100.0	0.00031	+0.004	339	335	-0.000203

There were no dangerous close approaches of the tool bag with the ISS or other space objects.

The fragment had high reflection characteristics both in the radar and optical frequency bands. So, the mean level of the radar cross-section (RCS) in the meter band was approximately 0.4 m^2 and in the decimeter band 0.12 m^2 . In the optical range its brightness was about 10.7 magnitudes which was equivalent to the diffuse sphere diameter $0.3 - 0.4 \text{ m}$. This magnitude allowed to steadily keep tracking the fragment with the help of optical sensors. Such a high level of brightness for such a small fragment was due in the first place to the white-silver material the bag had been made of.

One more peculiarity of the object's motion was the rather low value of its ballistic factor, namely $0.004 - 0.005 \text{ m}^2/\text{kg}$. This fact caused the low decrement of orbital period. And so, it stipulated a somewhat long lifetime of this fragment in orbit, which is not characteristic for such a class of space objects.

Before the time of re-entry the fragment orbit parameters were as in Table 3.

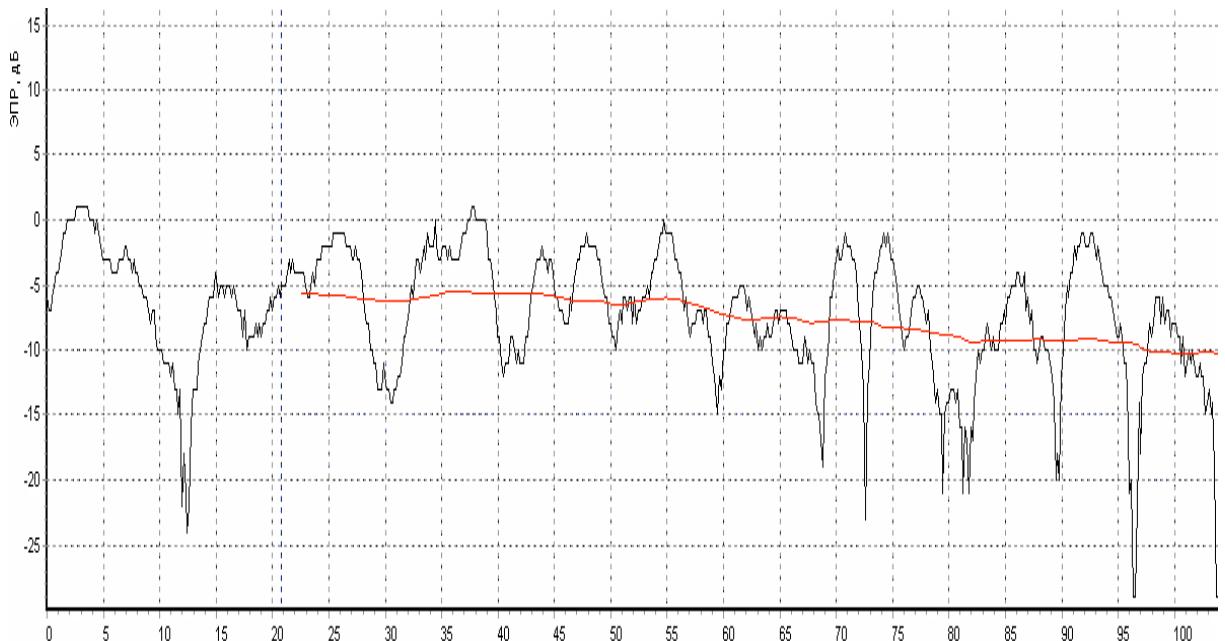
Table3. Orbit parameters

Date, time	T, min	i, deg	Ω , deg	ω , deg	e	Kb	h_a	h_p	ΔT , min/rev
03.08.2009 22:23:06 GMT	87.55	51.62	37.87	306.0	0.00073	+0.01	158	148	-0.079936

The last measurement was obtained by the RSSS radar located in Kazakhstan on August 3, 2009 at 09h 16m 19s GMT. Supposedly, the tool bag re-entered over the region with coordinates 48,9 N, 74,3 W in the Northern Atlantic (near East Cost of Canada) on August 3, 2009, 20h 27m 16s Moscow time.

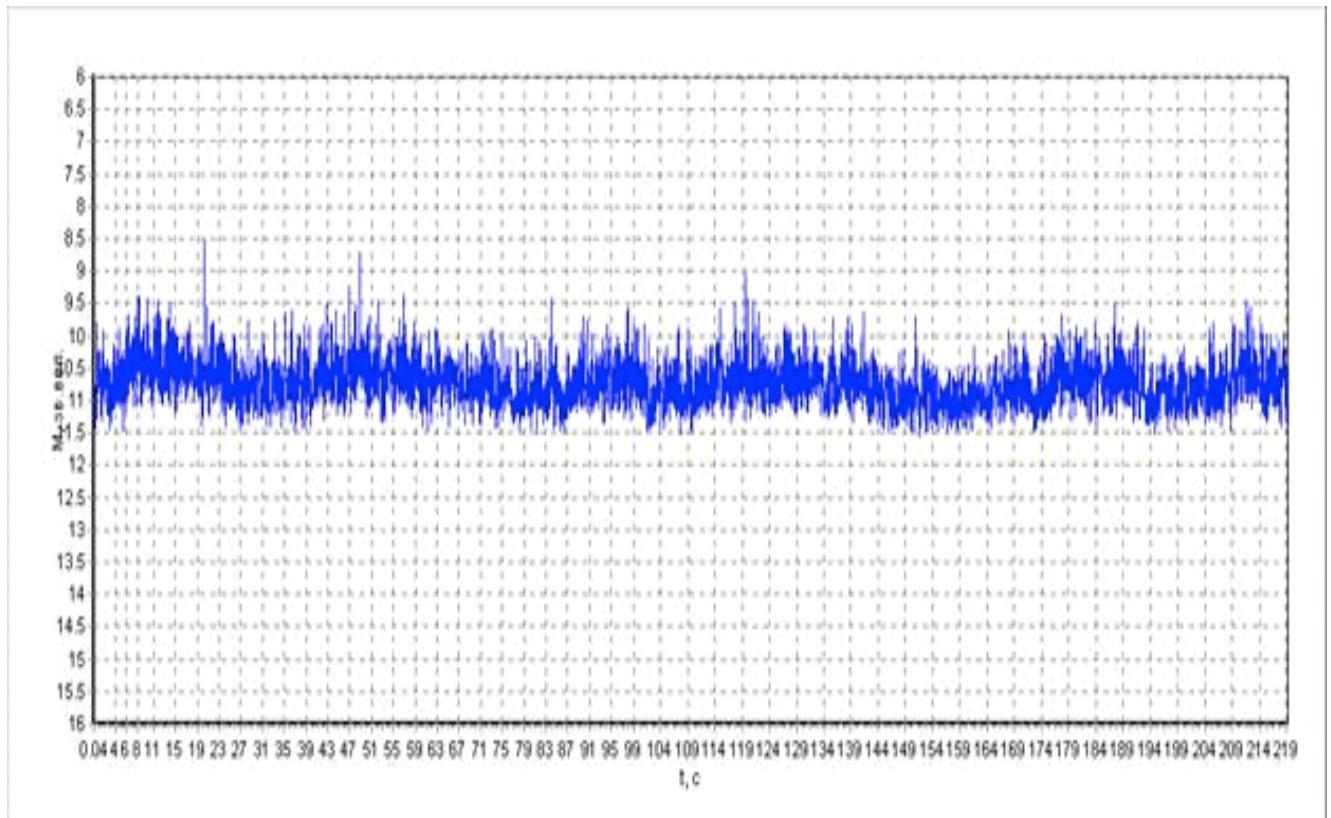
To provide the reliable and precise data during the last period of the tool bag lifetime some high precision radars and optical sensors were enlisted and tasked for tracking it.

At Fig.1 the typical radar and photometric signatures are shown.



a) Radar signature in decimeter frequency band

b)



b) Photometric signature

Fig.1 Non-metric information on SO № 19980670059.

The analysis allows drawing a conclusion on the rotation of the SO around its center of mass.