## **Satellite Laser Ranging Tracking through the Years**

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## Abstract

Satellites equipped with retroreflectors have been tracked by laser systems since 1964. Satellite laser ranging supports a variety of geodetic, earth sensing, navigation, and space science applications. This poster will show the history of satellite laser ranging from the late 1960's through the present and will include retro-equipped satellites on the horizon.

## **Satellite Tracking History**

Initial laser ranges to a satellite in Earth orbit took place in 1964 with the launch of Beacon Explorer-B (BE-B), the first satellite equipped with laser retroreflectors. Since that time, the global network of laser ranging sites has tracked over eighty satellites including arrays placed on the Moon. Satellite and Lunar laser ranging continue to make important contributions to scientific investigations into solid Earth, atmosphere, and ocean processes. SLR also provides Precise Orbit Determination (POD) for several Earth sensing missions (e.g., altimetry, etc.), leading to more accurate measurements of ocean surface, land, and ice topography. Several of these missions have relied on SLR when other radiometric tracking systems have failed (e.g., GPS and DORIS on TOPEX/Poseidon, PRARE on ERS-1, GPS on METEOR-3M and GFO-1) making SLR the only method for providing the POD required for instrument data products. A list of satellites equipped with retroreflectors (past, current, and future) and tracked by SLR is shown in Table 1. The table summarizes the data yield (approximate through fall 2008) and includes a list of any co-located instrumentation (e.g., GNSS, DORIS, or PRARE). Figure 1 shows this rich history in graphical format, as well as future plans, from mid-1960 through 2015. The satellite missions supported by laser ranging are shown in four categories: geodetic, Earth sensing, navigation, and space science or engineering applications.

The data generated by the laser ranging stations tracking these satellites, as well as products derived from these data, are available from the Crustal Dynamics Data Information System (CDDIS, *http://cddis.nasa.gov*). The CDDIS is NASA's active archive and information service of space geodesy data and products and currently serves as a key global data center for the ILRS. For over 25 years, the CDDIS has provided continuous, long term, public access to the data and product sets required for many interdisciplinary studies of the global Earth Science community,

Satellite         Start Date         End Date         of Years         of Passes         Instrument?           Current and Past Satellites         Oct-1996         Aug-1997         2         750           ADEOS-1         Oct-1996         Aug-1986          23         152,260           ALOS         Aug-2006         Aug-2006         1         90           ANDERR-Active         Jan-2007         May-2008         2         650           BE-C         Jan-1976          21         66,790           CHAMP         Jul-2000          9         13,650         GNSS           DIADEM-IC         Apr-1997         Nov-1997         1         2,590         Envisat         Apr-2002          7         34,820         DORIS           ERS-1         Jul-1991         Mar-2000         9         26,080         PRARE*         ERS-2         Apr-1995          20         15,720           Etalon-1         Jan-1989          20         15,890          2300         GNSS           Etalon-2         Jul-1989         Aug-2008         11         43,070         GNSS           GEOS-3         Oct-1998				Number	Number	Co-Located			
Current and Past Satellites           ADEOS-1         Oct-1996         Aug-1997         2         750           ADEOS-2         Dec-2002         Jan-2003         2         180           AJisai         Aug-1986          23         152,260           ALOS         Aug-2006         Aug-2007         1         430           ANDERR-Active         Jan-2007         Dec-2007         1         430           ANDERR-Passive         Jan-2007         May-2008         2         650           BE-C         Jan-1976          21         66,790           CHAMP         Jul-2000          9         13,650         GNSS           DIADEM-ID         Apr-1997         Nov-1997         1         2,550         Envisat         Apr-2002          7         34,820         DORIS           Etalon-1         Jan-1989          20         15,890         Etalon-2         15,890         Etalon-2         380           FIZEAU         Jun-1995         Oct-1998         4         4,790         GEOS-3         Oct-1998         4         4,790           GEO-1         Apr-1995         Jun-1999         5         5,	Satellite	Start Date	End Date	of Years	of Passes	Instrument?			
ADEOS-1         Oct.1996         Aug.1997         2         750           ADEOS-2         Dec.2002         Jan-2003         2         180           AJISai         Aug.2006         Aug.2006         1         90           ALOS         Aug.2006         Aug.2006         1         90           ANDERR-Active         Jan.2007         May.2008         2         650           BE-C         Jan.1976          21         66,790           CHAMP         Jul.2000          9         13,650         GNSS           DIADEM-IC         Apr.1997         Nov.1997         1         2,550         Envisat         Apr.2002          7         34,820         DORIS           ERS-1         Jul-1991         Mar.2000         9         26,080         PRAE*         ERS-2         Apr.1995          20         15,820           Etalon-1         Jan-1989          20         15,720         ETS-8         Mar.2007          2         390           FIZEAU         Jun-1995         Oct.1998         May.1999         2         2,130         GNSS           GFZ-1         Apr.1998         Aug.2008 <td< td=""><td>Current and Past Satel</td><td colspan="8">Current and Past Satellites</td></td<>	Current and Past Satel	Current and Past Satellites							
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Ajisai         Aug-1986          23         152,260           ALOS         Aug-2006         1         90            ANDERR-Active         Jan-2007         Dec-2007         1         430           ANDERR-Active         Jan-2007         May-2008         2         650           ANDERR-Passive         Jan-2007         May-2008         2         650           CHAMP         Jal-2000          21         66,790           CHAMP         Jal-2000          9         13,650         GNSS           DIADEM-IC         Apr-1997         Nov-1997         1         2,590         DORIS           Ers-1         Jal-1991         Mar-2000         9         26,080         PRARE*           ERS-1         Jal-1995          14         66,620         GNSS           Etaton-2         Jul-1989          20         15,720           ETS-8         Mar-2007          2         390           FTZEAU         Jun-1995         Oct-1988         4         4,790           GEOS-3         Oct-1988         May-2006          3         1,590           GIVE-A <td>ADEOS-2</td> <td>Dec-2002</td> <td>Jan-2003</td> <td>2</td> <td>180</td> <td></td>	ADEOS-2	Dec-2002	Jan-2003	2	180				
ALOS         Aug-2006         Aug-2006         1         90           ANDERR-Active         Jan-2007         Dec-2007         1         4.30           ANDERR-Passive         Jan-2007         May-2008         2         6.50           BE-C         Jan-1976          21         66.790           CHAMP         Jul-2000          9         13.650         GNSS           DIADEM-1D         Apr-1997         Nov-1997         1         2.500         DORIS           Erksat         Apr-2002          7         34.820         DORIS           ERS-1         Jul-1991         Mar-2000         9         26.080         PRARE*           ERS-2         Apr-1995          14         66.620         GNSS           Etalon-1         Jan-1989          20         15.720           ETS-8         Mar-2007          2         390           FIZEAU         Jun-1995         Oct-1998         4         4.790           GEOS-3         Oct-1998         Aug-2008         11         40         GNSS           GIOVE-A         May-2006          3         1.590         GNSS	Ajisai	Aug-1986		23	152,260				
ANDERR-Active         Jan-2007         Dec-2007         1         430           ANDERR-Passive         Jan-2007         May-2008         2         650           BE-C         Jan-1976          21         66,790           CHAMP         Jul-2000          9         13,650         GNSS           DIADEM-1C         Apr-1997         Nov-1997         1         2,350           DIADEM-1D         Apr-1997         Nov-1997         1         2,550           Envisat         Apr-2002          7         34,820         DORIS           Envisat         Apr-1995          14         66,620         GNSS           Etalon-1         Jan-1989          20         15,720           ETS-8         Mar-2007          2         390           FIZEAU         Jun-1995         Oct-1998         4         4,790           GEOS-3         Oct-1998         Aug-2008         11         43,070         GNSS           GFZ-1         Apr-1995         Jun-1999         5         5,140         GNSS           GIOVE-A         May-2006          1         140         GNSS <t< td=""><td>ALOS</td><td>Aug-2006</td><td>Aug-2006</td><td>1</td><td>90</td><td></td></t<>	ALOS	Aug-2006	Aug-2006	1	90				
ANDERR-Passive         Jan-2007         May-2008         2         650           BE-C         Jan-1976          21         66,790           CHAMP         Jul-2000          9         13,650         GNSS           DIADEM-IC         Apr-1997         Nov-1997         1         2,350         Envisat         Apr-2002          7         34,820         DORIS           ERS-1         Jul-1991         Mar-2000         9         26,680         PRARE*           ERS-2         Apr-1995          14         66,620         GNSS           Etalon-1         Jan-1989          20         15,890         Etalon-2         Jul-1989          2         300           FTZEAU         Jun-1995         Oct-1998         4         4,790         GEOS-3         Oct-1998         Aug-2008         11         43,070         GNSS           GIOVE-A         May-2008          1         140         GNSS           GIOVE-A         May-2008          1         140         GNSS           GIOVE-A         May-2008          1         140         GNSS           GIOVE-A	ANDERR-Active	Jan-2007	Dec-2007	1	430				
BE-C         Jan-1976          21         66.790           CHAMP         Jul-2000          9         13.650         GNSS           DIADEM-IC         Apr-1997         Nov-1997         1         2.350           Envisat         Apr-2002          7         34.820         DORIS           ERS-1         Jul-1991         Mar-2000         9         26.680         PRARE*           ERS-2         Apr-1995          14         66.620         GNSS           Etalon-1         Jan-1989          20         15.890         Etalon-2           ETS-8         Mar-2007          2         390         Etalon-2         GNSS           GEOS-3         Oct-1998         Aug-2008         11         43.070         GNSS           GFO-1         Apr-1995         Jun-1999         5         5.140         GNSS           GIOVE-A         May-2006          1         140         GNSS           GIOVE-A         May-2006          15         47.980         GNSS           GP-B         Jul-2004         Jun-2006         3         2.910         GNSS <t< td=""><td>ANDERR-Passive</td><td>Jan-2007</td><td>May-2008</td><td>2</td><td>650</td><td></td></t<>	ANDERR-Passive	Jan-2007	May-2008	2	650				
CHAMP         Jul-2000          9         13.650         GNSS           DIADEM-IC         Apr-1997         Nov-1997         1         2.350            Envisat         Apr-2002          7         34.820         DORIS           ERS-1         Jul-1991         Mar-2000         9         26.080         PRARE*           ERS-2         Apr-1995          14         66.620         GNSS           Etalon-1         Jan-1989          20         15.890            Etalon-2         Jul-1989          2         390             FIZEAU         Jun-1995         Oct-1998         4         4.790             GEOS-3         Oct-1998         Aug-2008         11         43.070         GNSS*            GF2-1         Apr-1995         Jun-1999         5         5.140             GNSS            GIOVE-A         May-2006          1         140         GNSS              GNSS          GNSS         GIOVE-A         May-	BE-C	Jan-1976		21	66,790				
DIADEM-IC         Apr-1997         Nov-1997         1         2,350           DIADEM-ID         Apr-1997         Nov-1997         1         2,590           Envisat         Apr-2002          7         34,820         DORIS           ERS-1         Jul-1991         Mar-2000         9         26,080         PRARE*           ERS-2         Apr-1995          14         66,620         GNSS           Etalon-1         Jan-1989          20         15,780           Etalon-2         Jul-1989          20         390           FTZEAU         Jun-1995         Oct-1998         4         4,790           GEOS-3         Oct-1998         May-1999         2         2,130           GEOS-1         Apr-1995         Jun-1999         5         5,140           GIOVE-A         May-2006          3         1,590         GNSS           GIOVE-B         May-2008          1         140         GNSS           GIOVE-B         May-2008          15         47,080         GNSS           GPS-3         Oct-1994          15         6,500         GNSS	CHAMP	Jul-2000		9	13,650	GNSS			
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Etalon-1         Jan-1989          20         15,890           Etalon-2         Jul-1989          20         15,720           ETS-8         Mar-2007          2         390           FZEAU         Jun-1995         Oct-1998         4         4,790           GEOS-3         Oct-1998         Aug-2008         11         43,070         GNS8*           GFZ-1         Apr-1995         Jun-1999         5         5,140         GIOVE-A         May-2006          3         1,590         GNSS           GIOVE-A         May-2008          15         47,980         GNSS         GNSS           GIOVE-B         May-2004         Jun-2006         3         2,910         GNSS           GP-B         Jul-2004         Jun-2006         3         2,910         GNSS           GPS-35         Oct-1993          16         7,440         GNSS           GRACE-A         Mar-2002          7         11,860         GNSS           GRACE-A         Mar-2003          8         48,110         GNSS,DORIS           Jason-1         Dec-2001          8	ERS-2	Apr-1995		14	66,620	GNSS			
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FIZEAU         Jun-1995         Oct-1998         4         4,790           GE0S-3         Oct-1998         May-1999         2         2,130           GFO-1         Apr-1998         Aug-2008         11         43,070         GNSS*           GFZ-1         Apr-1995         Jun-1999         5         5,140         GIOVE-A         May-2006          3         1,590         GNSS           GIOVE-B         May-2008          1         140         GNSS         GNSS           GLONASS (31 sats.)         Oct-1994          15         47,980         GNSS           GPS-35         Oct-1993          16         7,440         GNSS           GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2002          7         11,860         GNSS           ICESat         Mar-2003          6         5,320         GNSS, DORIS           Jason-1         Dec-2001          1         990         GNSS, DORIS           LAGEOS-1         May-1976          3         152,350         ILAGEOS-1           LAGEOS-2	ETS-8	Mar-2007		2	390				
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GFO-1         Apr-1998         Aug-2008         11         43,070         GNSS*           GFZ-1         Apr-1995         Jun-1999         5         5,140         GIOVE-A         May-2006          3         1,590         GNSS           GIOVE-A         May-2008          1         140         GNSS           GLONASS (31 sats.)         Oct-1994          15         47,980         GNSS           GPS-35         Oct-1993          16         7,440         GNSS           GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2002          7         11,860         GNSS           GRACE-B         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          17         88,750            LAGEOS-1         May-1976          17         88,750            LAGEOS-2         Oct-1992          17         88,750	GEOS-3	Oct-1998	May-1999	2	2.130				
GFZ-1         Apr-1995         Jun-1999         5         5,140           GIOVE-A         May-2006          3         1,590         GNSS           GIOVE-B         May-2008          1         140         GNSS           GLONASS (31 sats.)         Oct-1994          15         47,980         GNSS           GP-B         Jul-2004         Jun-2006         3         2,910         GNSS           GPS-35         Oct-1993          16         7,440         GNSS           GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2003          6         5,320         GNSS           ICESat         Mar-2003          6         5,320         GNSS, DORIS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           LAGEOS-1         May-1976          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994 <t< td=""><td>GFO-1</td><td>Apr-1998</td><td>Aug-2008</td><td>11</td><td>43.070</td><td>GNSS*</td></t<>	GFO-1	Apr-1998	Aug-2008	11	43.070	GNSS*			
GIOVE-A         May-2006          3         1.590         GNSS           GIOVE-B         May-2008          1         140         GNSS           GLONASS (31 sats.)         Oct-1994          15         47,980         GNSS           GP-B         Jul-2004         Jun-2006         3         2,910         GNSS           GPS-35         Oct-1993          16         7,440         GNSS           GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2002          7         12,550         GNSS           ICESat         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350         LAGEOS-2           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3M	GFZ-1	Apr-1995	Jun-1999	5	5,140				
GIOVE-B         May-2008          1         140         GNSS           GLONASS (31 sats.)         Oct-1994          15         47,980         GNSS           GP-B         Jul-2004         Jun-2006         3         2,910         GNSS           GPS-35         Oct-1993          16         7,440         GNSS           GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2002          7         11,860         GNSS           GRACE-B         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1994<	GIOVE-A	May-2006		3	1.590	GNSS			
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GP-B         Jul-2004         Jun-2006         3         2,910         GNSS           GPS-35         Oct-1993          16         7,440         GNSS           GPS-36         Apr-1994          15         6,500         GNSS           GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2002          7         11,860         GNSS           ICESat         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3M         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996	GLONASS (31 sats.)	Oct-1994		15	47.980	GNSS			
GPS-35         Oct-1993          16         7,440         GNSS           GPS-36         Apr-1994          15         6,500         GNSS           GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2002          7         11,860         GNSS           ICESat         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           MOON         Jun-1994         Oct-1994         1         60         0         0           OICETS         Apr-2006 <td< td=""><td>GP-B</td><td>Jul-2004</td><td>Jun-2006</td><td>3</td><td>2.910</td><td>GNSS</td></td<>	GP-B	Jul-2004	Jun-2006	3	2.910	GNSS			
GPS-36         Apr-1994          15         6,500         GNSS           GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2002          7         11,860         GNSS           ICESat         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3M         Dec-2001         Mar-2006          13         1,210           MSTI-2         Jun-1996          13         1,210            Reflector         Dec-2001         Aug-2004	GPS-35	Oct-1993		16	7,440	GNSS			
GRACE-A         Mar-2002          7         12,550         GNSS           GRACE-B         Mar-2003          7         11,860         GNSS           ICESat         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           MOON         Jun-1996          13         1,210         14           MSTI-2         Jun-1994         Oct-1994         1         60         100           OICETS         Apr-2006	GPS-36	Apr-1994		15	6.500	GNSS			
GRACE-B         Mar-2002          7         11,860         GNSS           ICESat         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210         1           MSTI-2         Jun-1994         Oct-1994         1         60           OICETS         Apr-2006          1         120           Reflector         Dec-1995         Oct-1998         4         2,020	GRACE-A	Mar-2002		7	12,550	GNSS			
ICESat         Mar-2003          6         5,320         GNSS           Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3M         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210         10           MSTI-2         Jun-1994         Oct-1994         1         60         10         0ICETS         Apr-2006          1         120         120         120         120         120         120         120         120         120         120         120         120         120         120         123	GRACE-B	Mar-2002		7	11.860	GNSS			
Jason-1         Dec-2001          8         48,110         GNSS, DORIS           Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3         Jan-1994         Oct-1994         1         60         60           OON         Jun-1996          13         1,210         100           MSTI-2         Jun-1994         Oct-1994         1         60         10         100         100         100	ICESat	Mar-2003		6	5.320	GNSS			
Jason-2         Jun-2008          1         990         GNSS, DORIS           LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3M         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210         1000           MSTI-2         Jun-1994         Oct-1994         1         60         6           OICETS         Apr-2006          1         120         120           Reflector         Dec-2001         Aug-2004         4         3,620         123,160           Starlette         Jan-1976          33         123,160         123,160         123,160         123,160         123,160         123,160         123,160         124,100         133,1800         125,168         125,168         125	Jason-1	Dec-2001		8	48.110	GNSS, DORIS			
LAGEOS-1         May-1976          33         152,350           LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210           MSTI-2         Jun-1996          1         120           OICETS         Apr-2006          1         120           Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3	Jason-2	Jun-2008		1	990	GNSS, DORIS			
LAGEOS-2         Oct-1992          17         88,750           LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210           MSTI-2         Jun-1994         Oct-1994         1         60           OICETS         Apr-2006          1         120           Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007 <t< td=""><td>LAGEOS-1</td><td>May-1976</td><td></td><td>33</td><td>152 350</td><td>ortos, Dortas</td></t<>	LAGEOS-1	May-1976		33	152 350	ortos, Dortas			
LARETS         Nov-2003         Aug-2008         6         19,740           LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3M         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210           MSTI-2         Jun-1994         Oct-1994         1         60           OICETS         Apr-2006          1         120           Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007	LAGEOS-2	Oct-1992		17	88.750				
LRE         Dec-2001         Mar-2002         2         40           METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3M         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210         1           MSTI-2         Jun-1994         Oct-1994         1         60         0           OICETS         Apr-2006          1         120         1         1           Reflector         Dec-2001         Aug-2004         4         3,620         1 <td>LARETS</td> <td>Nov-2003</td> <td>Aug-2008</td> <td>6</td> <td>19.740</td> <td></td>	LARETS	Nov-2003	Aug-2008	6	19.740				
METEOR-3         Jan-1994         Nov-1995         2         6,280         PRARE*           METEOR-3M         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210           MSTI-2         Jun-1994         Oct-1994         1         60           OICETS         Apr-2006          1         120           Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680            TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*	LRE	Dec-2001	Mar-2002	2	40				
METEOR-3M         Dec-2001         Mar-2006         6         1,800         GNSS*           MOON         Jun-1996          13         1,210           MSTI-2         Jun-1994         Oct-1994         1         60           OICETS         Apr-2006          1         120           Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680         TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480         TELA	METEOR-3	Jan-1994	Nov-1995	2	6.280	PRARE*			
MOON         Jun-1996          13         1,210           MSTI-2         Jun-1994         Oct-1994         1         60           OICETS         Apr-2006          1         120           Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480         GNSS*, DORIS*	METEOR-3M	Dec-2001	Mar-2006	6	1.800	GNSS*			
MSTI-2         Jun-1994         Oct-1994         1         60           OICETS         Apr-2006          1         120           Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480         GNSS*, DORIS*	MOON	Jun-1996		13	1.210				
OICETS         Apr-2006          1         120           Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480         GNSS*, DORIS*	MSTI-2	Jun-1994	Oct-1994	1	60				
Reflector         Dec-2001         Aug-2004         4         3,620           RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480         GNSS*, DORIS*	OICETS	Apr-2006		1	120				
RESURS         Dec-1995         Oct-1998         4         2,020           Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680            TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480	Reflector	Dec-2001	Aug-2004	4	3.620				
Starlette         Jan-1976          33         123,160           STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680            TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480	RESURS	Dec-1995	Oct-1998	4	2.020				
STARSHINE-3         Oct-2001         Jun-2003         3         50           Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680            TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480	Starlette	Jan-1976		33	123.160				
Stella         Sep-1993          16         62,990           SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680           TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480         1007	STARSHINE-3	Oct-2001	Jun-2003	3	50				
SUNSAT         May-1999         May-2001         3         1,800           TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680            TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480	Stella	Sep-1993		16	62.990				
TerraSAR-X         Jun-2007          2         3,070         GNSS           TiPS         Jun-1996         Oct-1997         2         1,680            TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480	SUNSAT	May-1999	May-2001	3	1.800				
TiPS         Jun-1996         Oct-1997         2         1,680           TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480         1007	TerraSAR-X	Jun-2007		2	3.070	GNSS			
TOPEX         Jan-1992         Dec-2005         14         105,060         GNSS*, DORIS*           WESTPAC         Jul-1998         Jan-2002         5         5,480	TiPS	Jun-1996	Oct-1997	2	1.680				
WESTPAC         Jul-1998         Jan-2002         5         5,480           ZELA         Mar 1007         Jul 1007         1         150	TOPEX	Jan-1992	Dec-2005	14	105.060	GNSS*. DORIS*			
ZELA Mag 1007 L. 1007 1 150	WESTPAC	Jul-1998	Jan-2002	5	5,480	,			
ZEIA   MAT-1997   JUI-1997   1   100	ZEIA	Mar-1997	Jul-1997	1	150				

 Table 1. ILRS Satellite Tracking Information

Future Satellites						
	Launch	<b>Co-Located</b>				
Satellite	Date	Instrument				
COMPASS-M1	2008	GNSS				
GOCE	2009	GNSS				
SOHLA-1	2009	GNSS				
LRO-LR	2009					
PROBA-2	2009	GNSS				
GIOVE-A2		GNSS				
QZS-1	2009					
TanDEM-X	2009	GNSS				
Galileo	2009	GNSS				
NPOESS	2012	GNSS				

 Table 1. ILRS Satellite Tracking Information (continued)

Note: \* indicates co-located instrument failure



## Figure 1. Satellite and Lunar Laser Ranging Tracking History