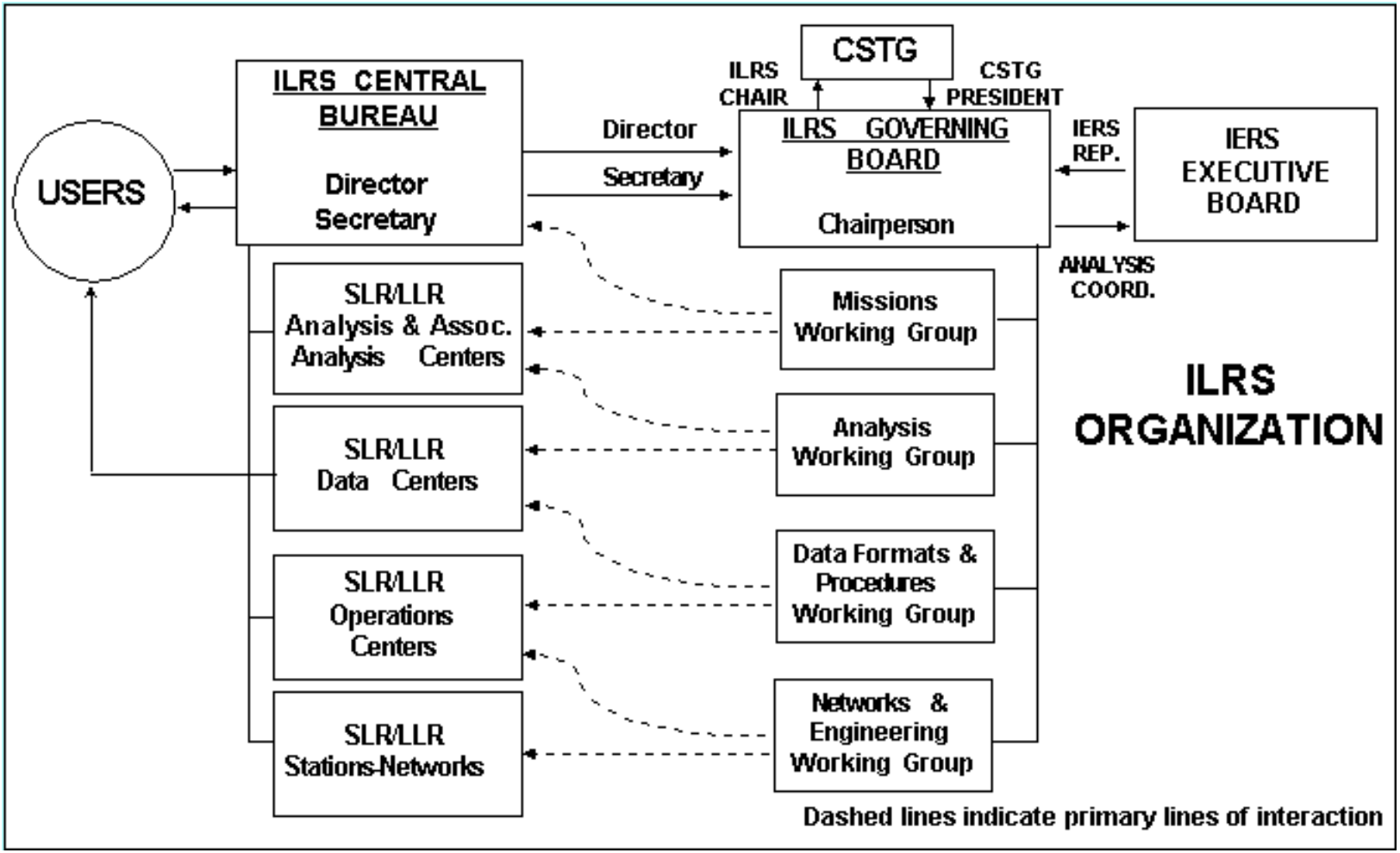
The Contribution of SLR to Satellite Altimeter Missions

R. Noomen

GAMBLE workshop

November 7-8, 2002, Delft, The Netherlands

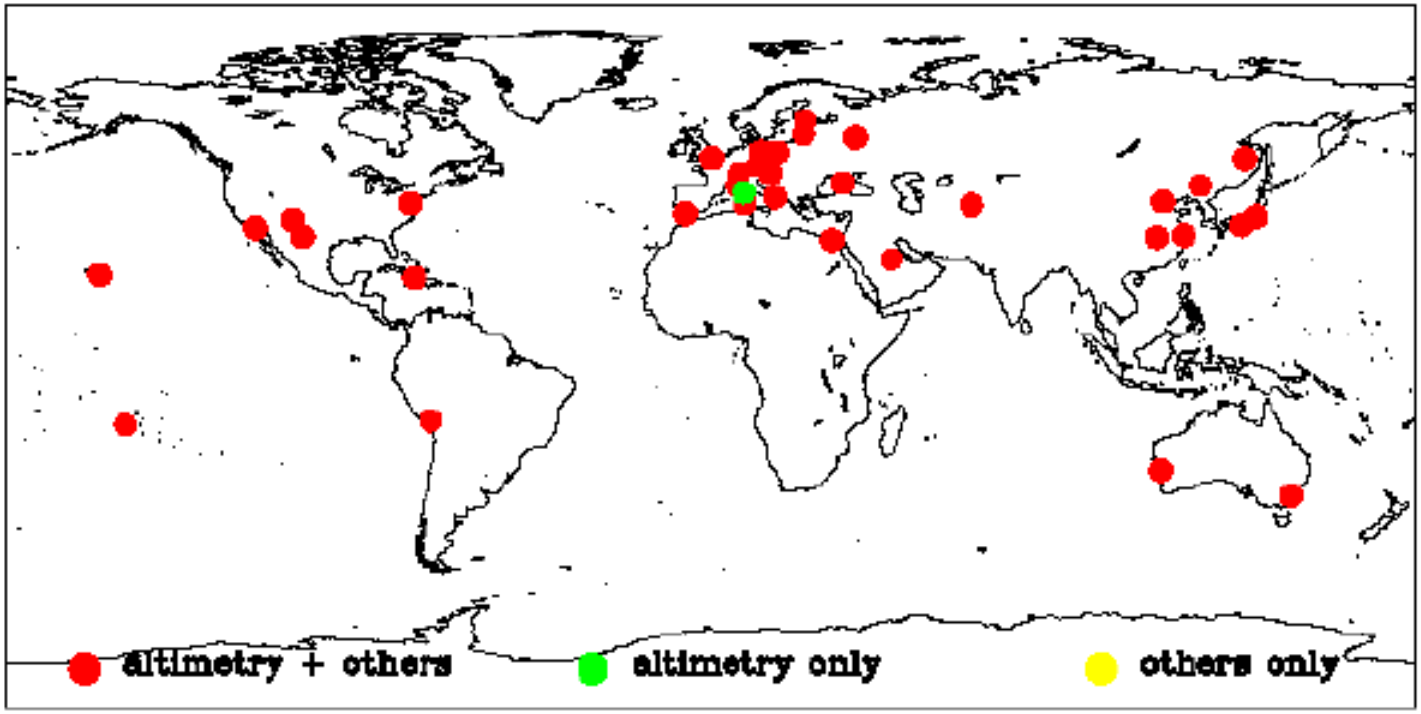

CSTG
ILRS CHAIR
CSTG PRESIDENT
ILRS CENTRAL BUREAU
Director
Secretary
Director
Secretary
ILRS GOVERNING BOARD
Chairperson
IERS REP.
IERS EXECUTIVE BOARD
ANALYSIS COORD.
USERS
SLR/LLR Analysis & Assoc. Analysis Centers
SLR/LLR Data Centers
SLR/LLR Operations Centers
SLR/LLR Stations-Networks
Missions Working Group
Analysis Working Group
Data Formats & Procedures Working Group
Networks & Engineering Working Group
ILRS ORGANIZATION
Dashed lines indicate primary lines of interaction

General SLR Developments

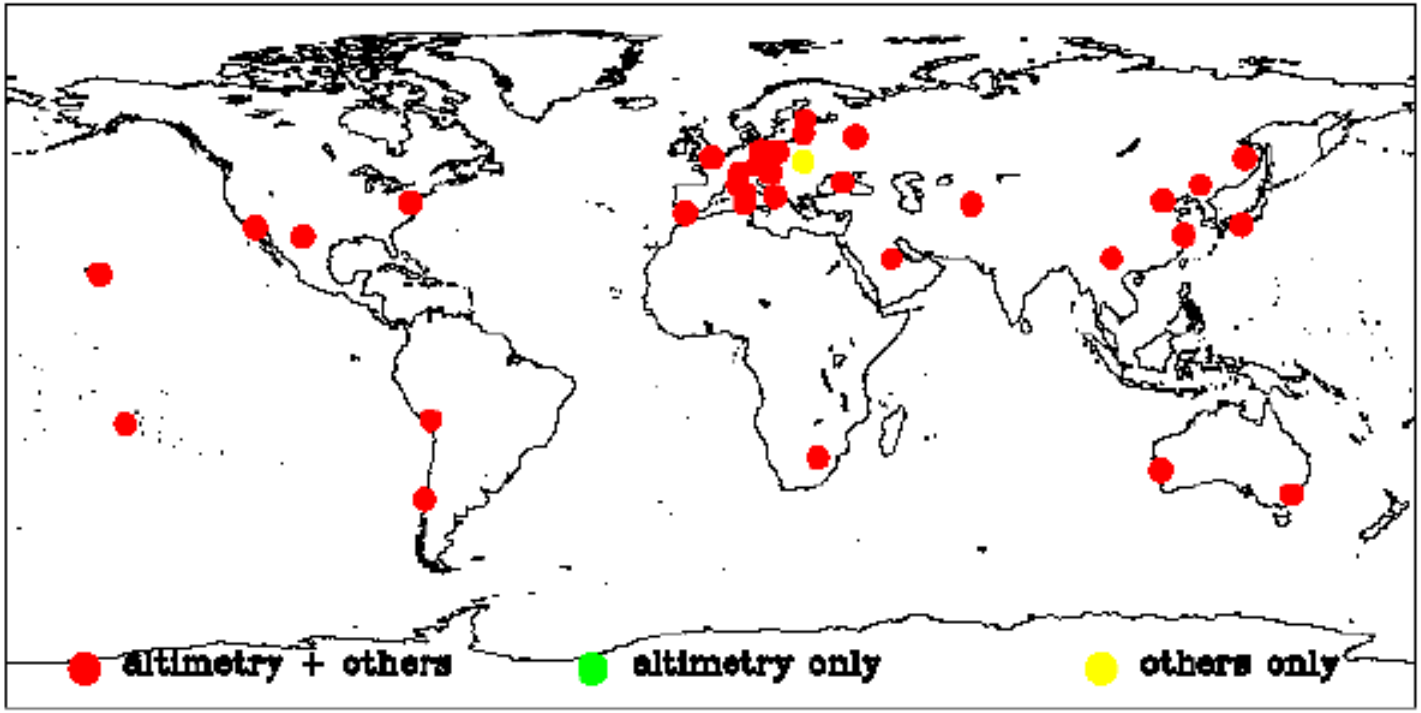
- Network improvements
  - Quantity
  - Quality
  - Automation

- Modeling improvements
  - Troposphere
  - Center-of-mass offset
  - Gravity field, surface forces, …

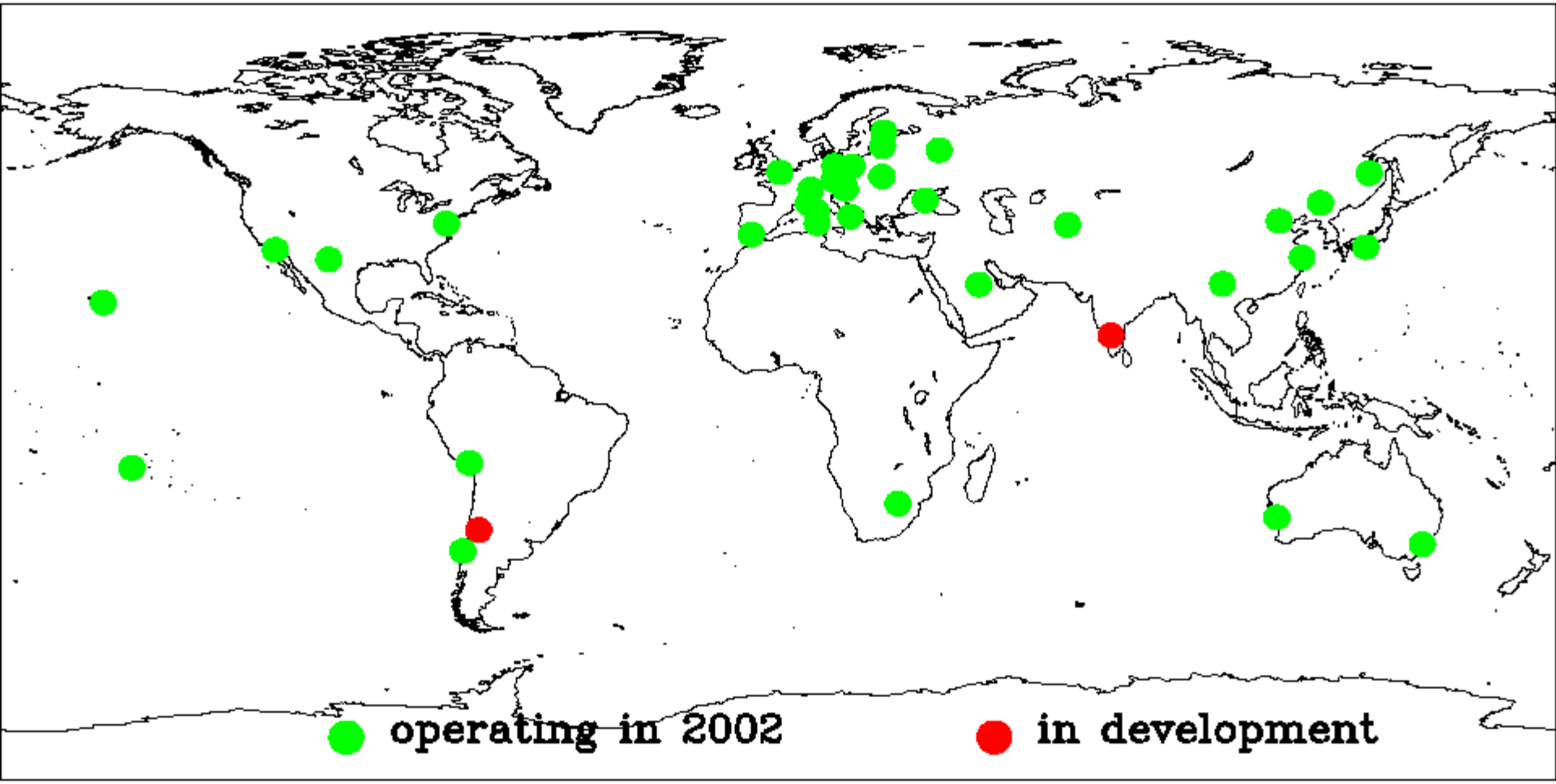
SLR Network 1997



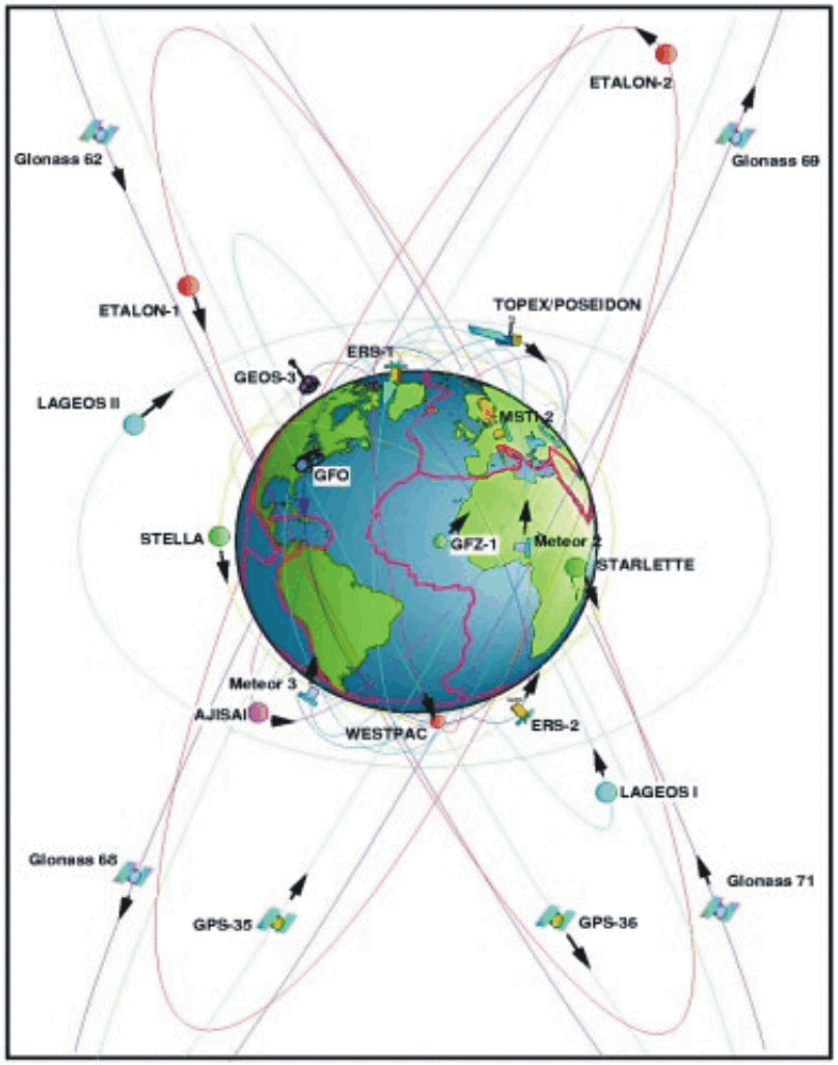
SLR Network 2002

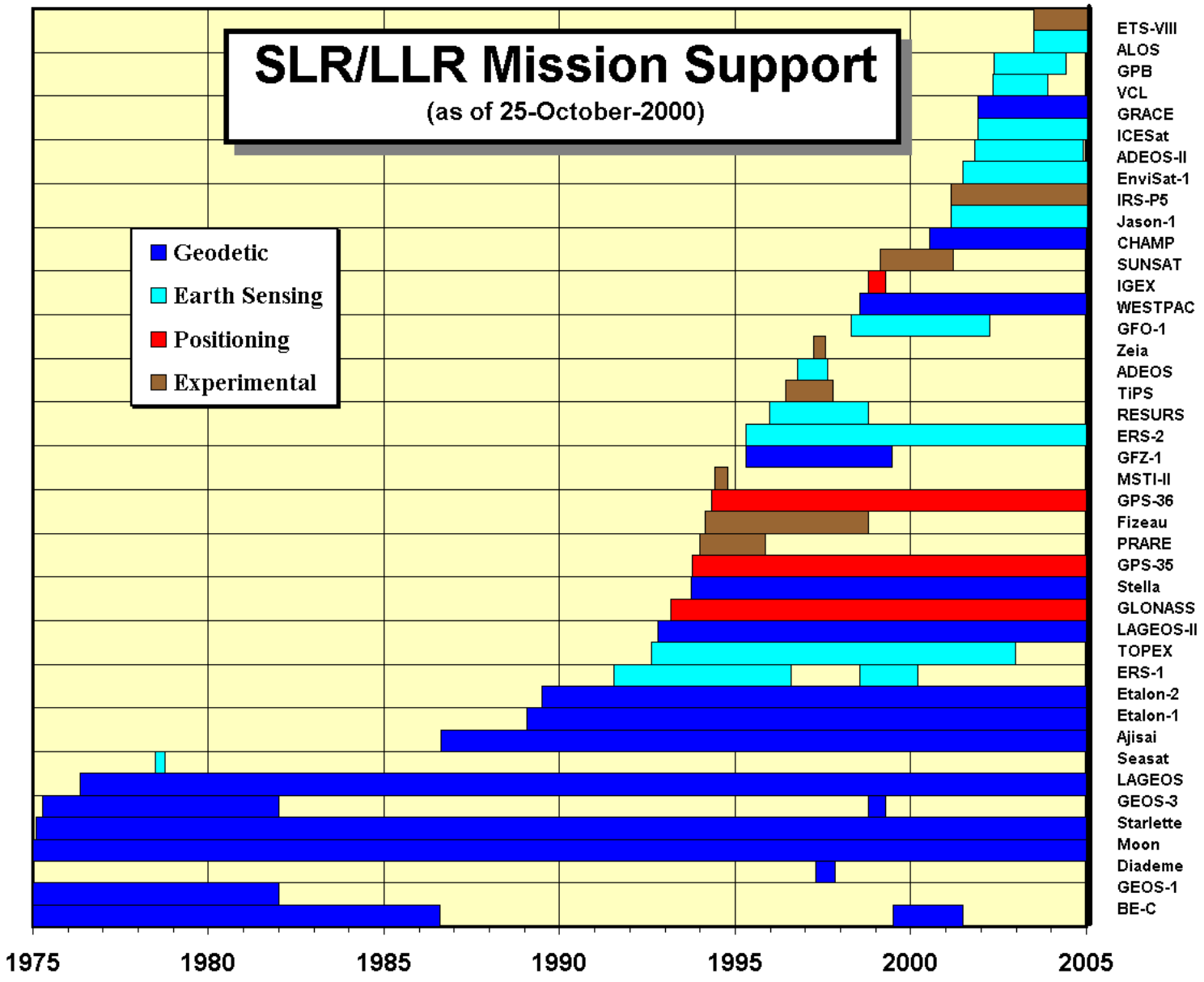


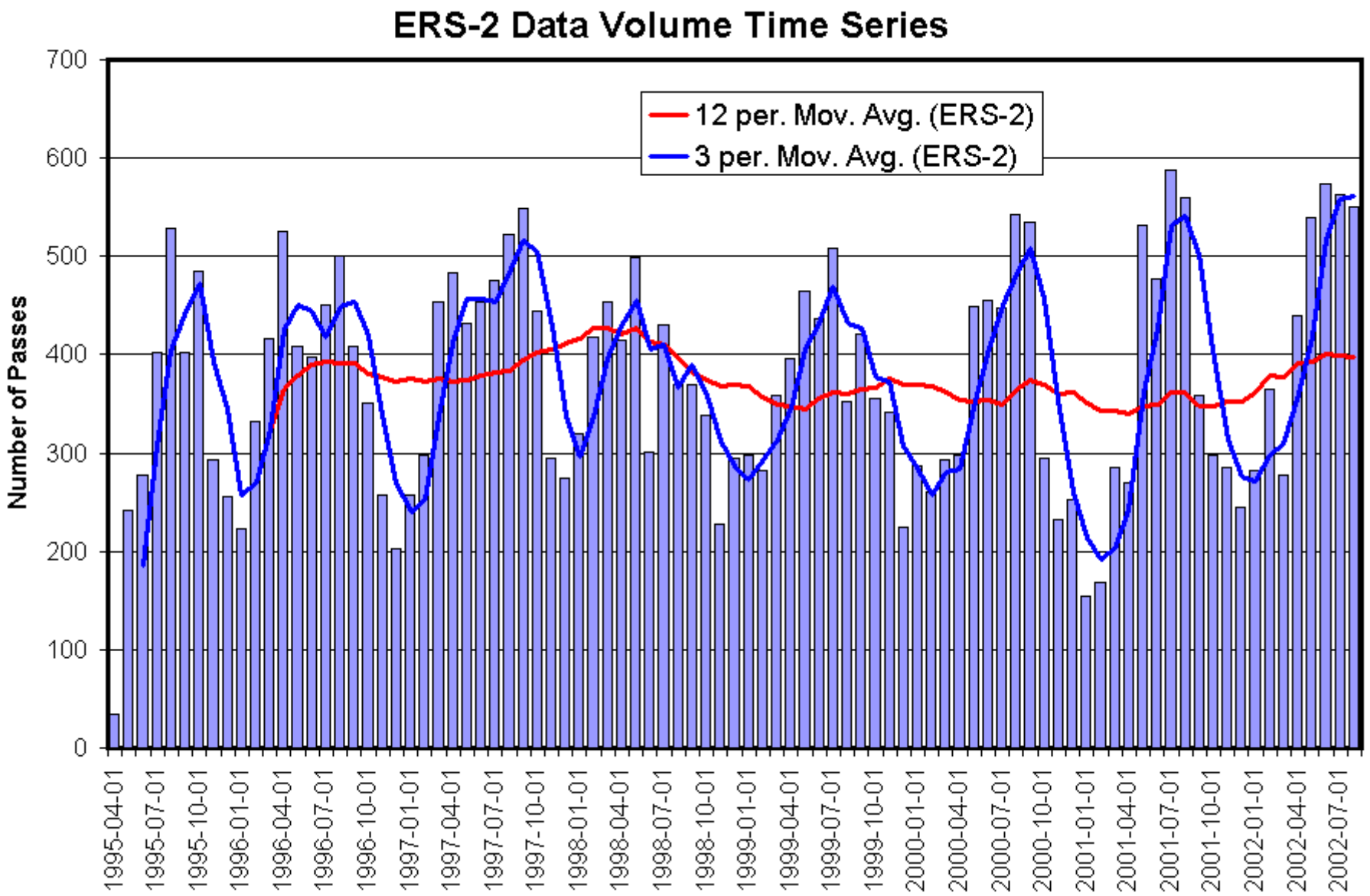
SLR Network in 2007 ??

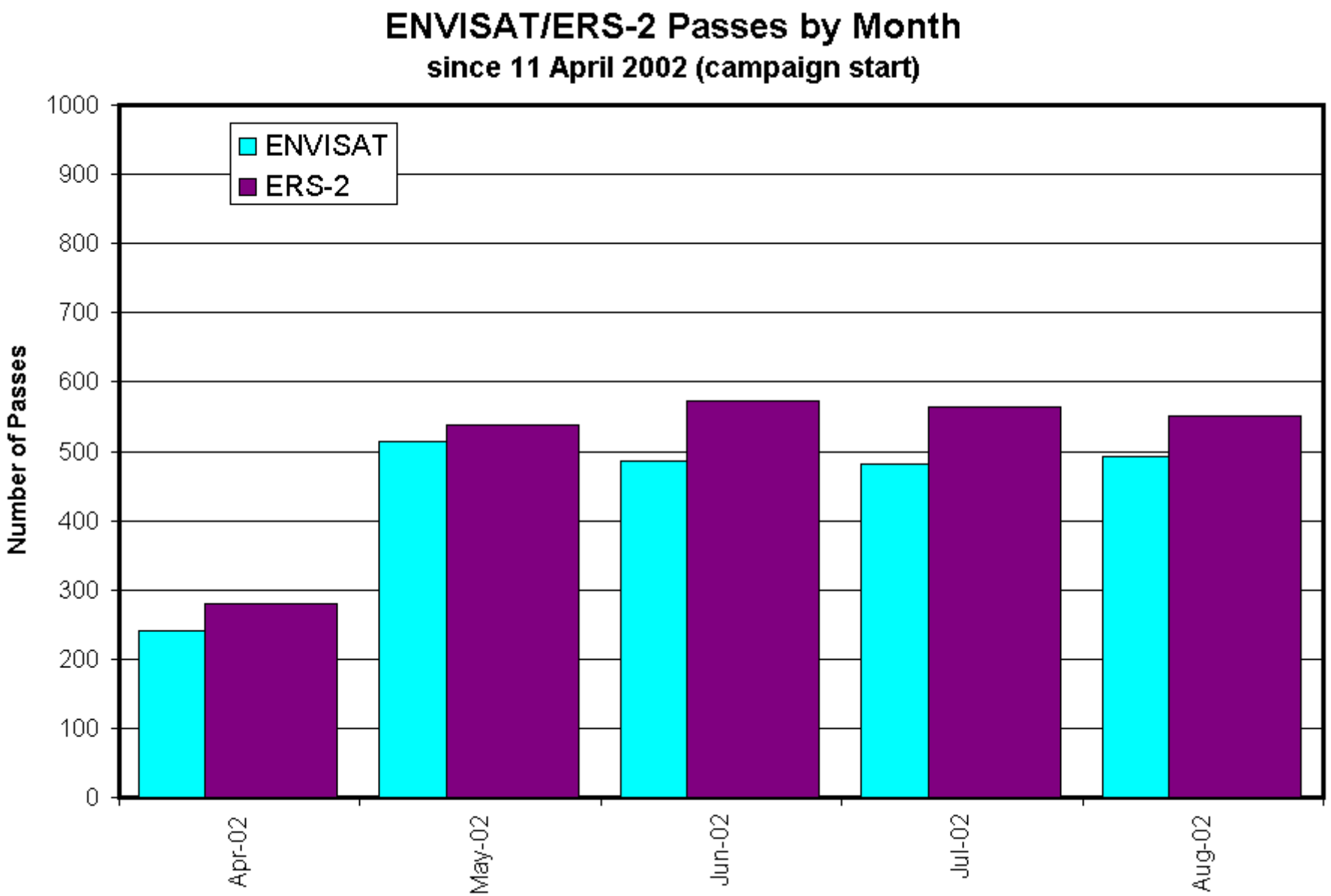


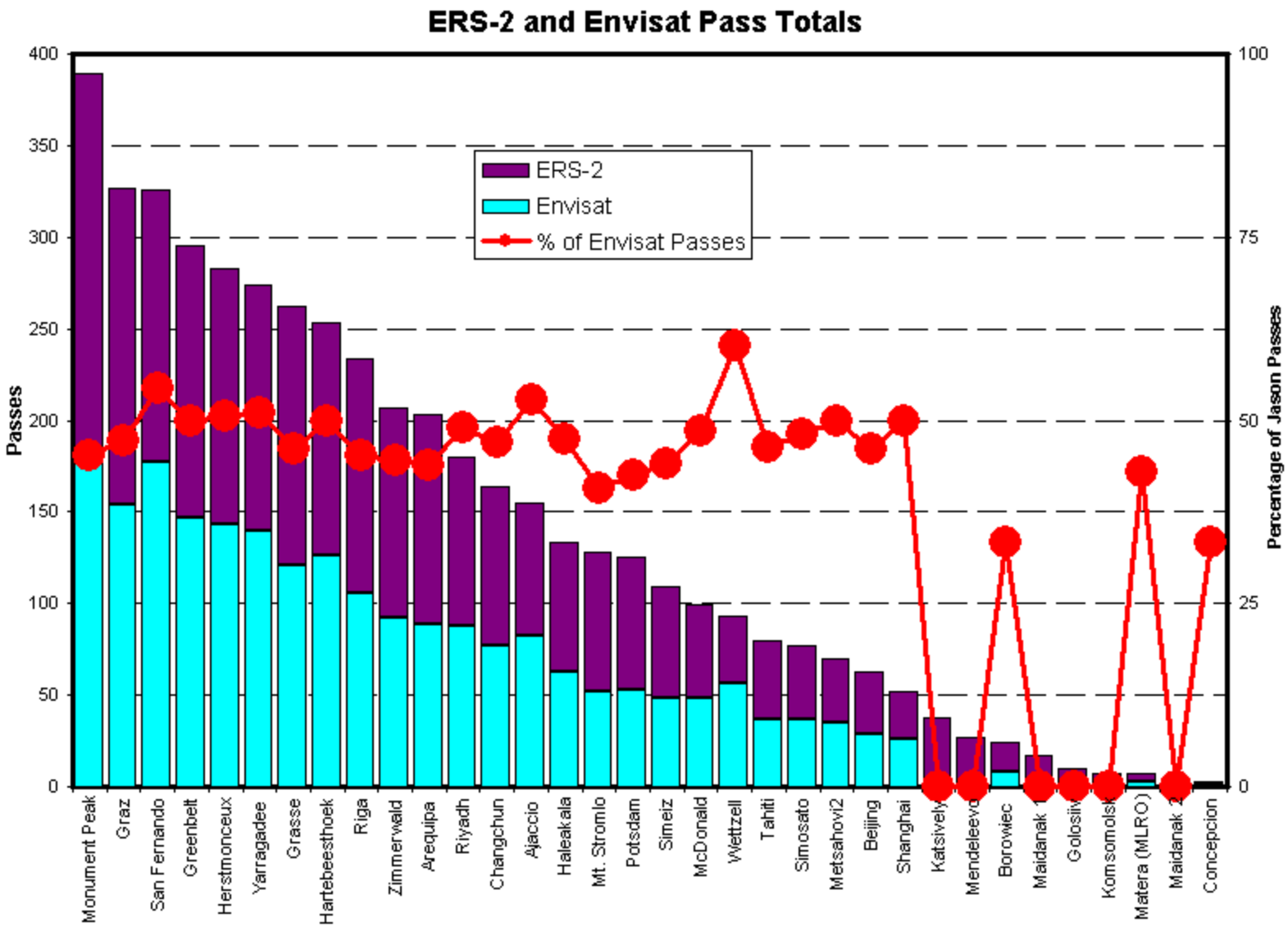
Overview of satellites tracked by SLR

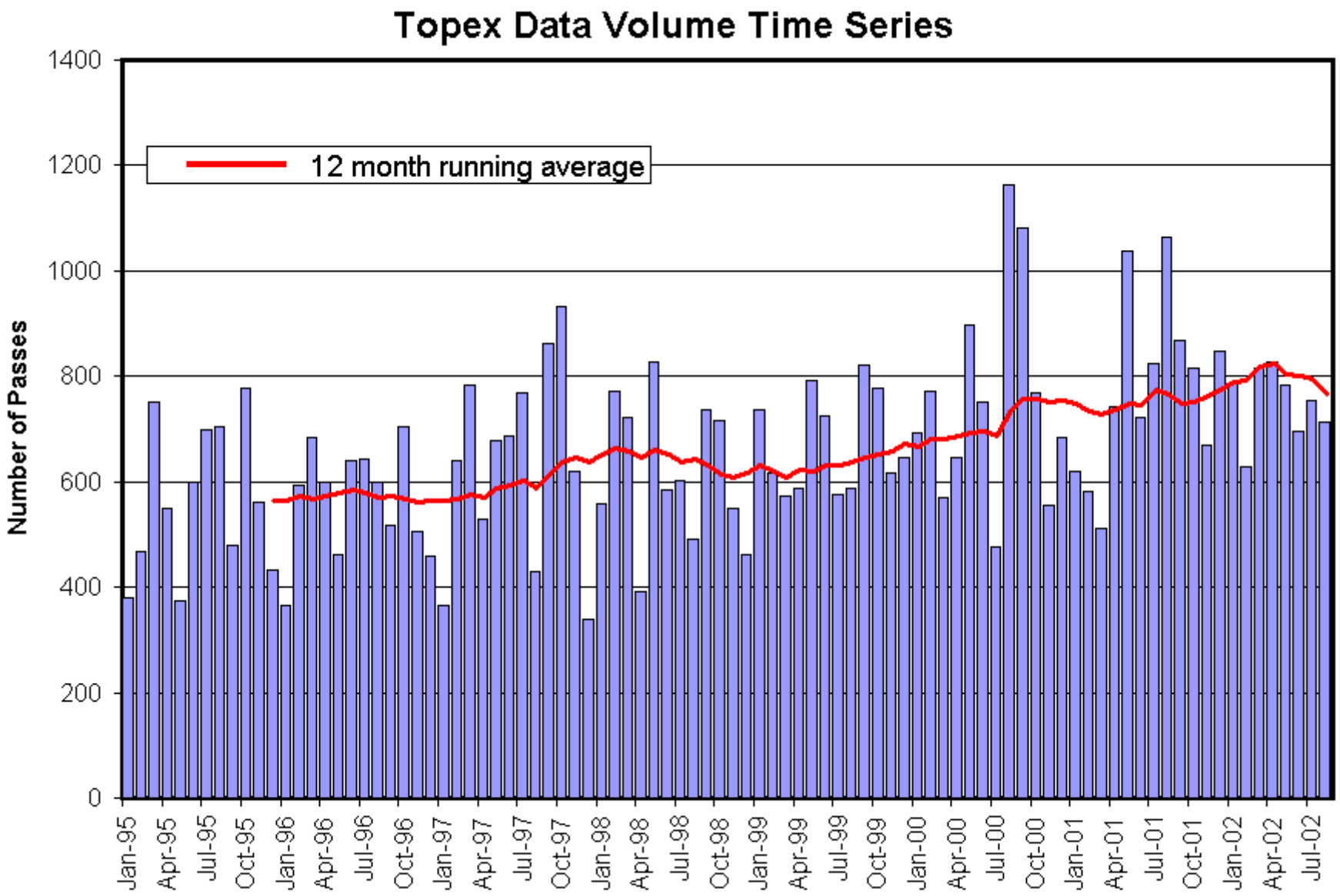


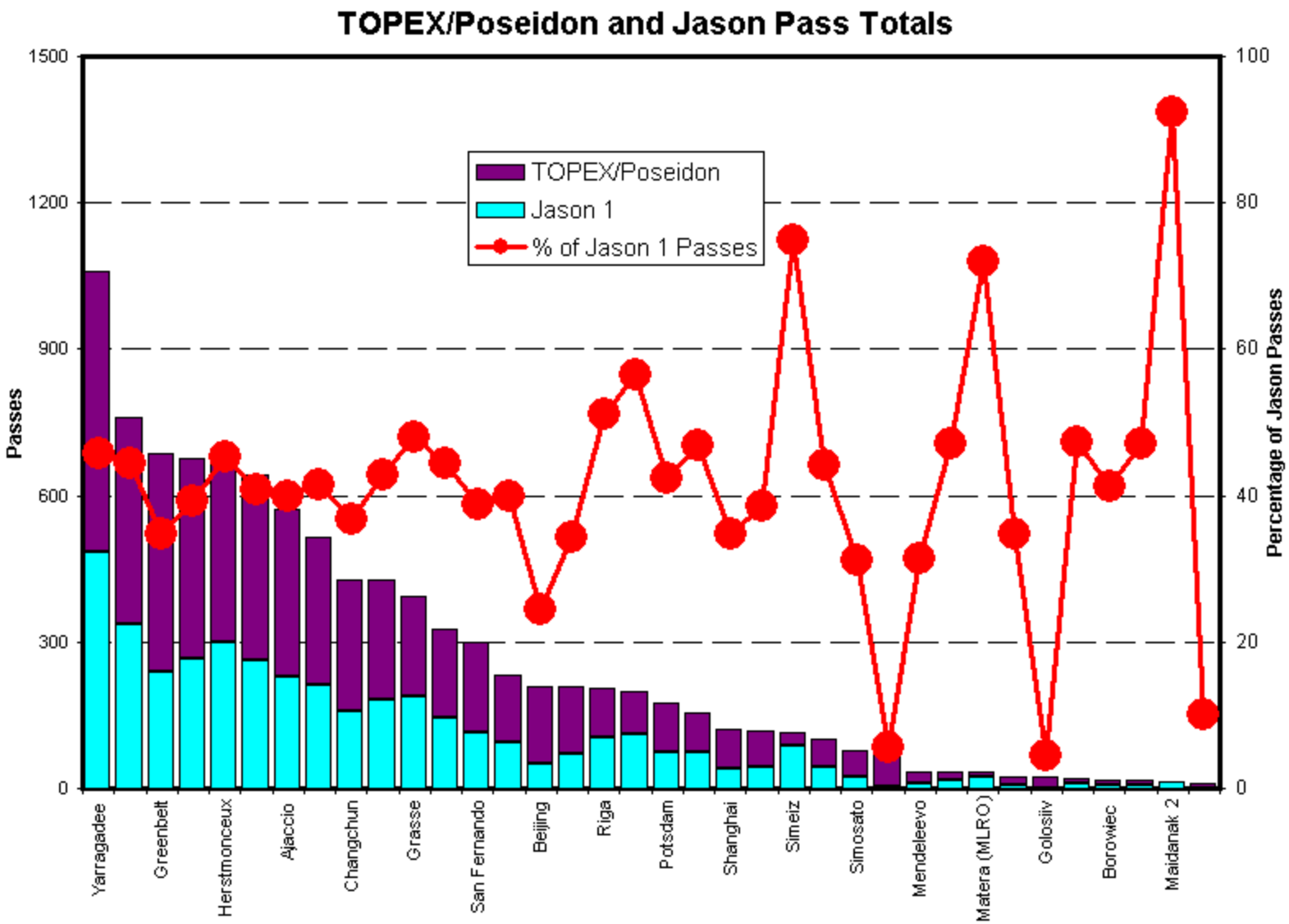

SLR/LLR Mission Support
(as of 25-October-2000)
Geodetic
Earth Sensing
Positioning
Experimental
ETS-VIII
ALOS
GPB
VCL
GRACE
ICESat
ADEOS-II
EnviSat-1
IRS-P5
Jason-1
CHAMP
SUNSAT
IGEX
WESTPAC
GFO-1
Zeia
ADEOS
TiPS
RESURS
ERS-2
GFZ-1
MSTI-II
GPS-36
Fizeau
PRARE
GPS-35
Stella
GLONASS
LAGEOS-II
TOPEX
ERS-1
Etalon-2
Etalon-1
Ajisai
Seasat
LAGEOS
GEOS-3
Starlette
Moon
Diademe
GEOS-1
BE-C
1975
1980
1985
1990
1995
2000
2005


ERS-2 Data Volume Time Series
12 per. Mov. Avg. (ERS-2)
3 per. Mov. Avg. (ERS-2)
Number of Passes
700
600
500
400
300
200
100
0
1995-04-01
1995-07-01
1995-10-01
1996-01-01
1996-04-01
1996-07-01
1996-10-01
1997-01-01
1997-04-01
1997-07-01
1997-10-01
1998-01-01
1998-04-01
1998-07-01
1998-10-01
1999-01-01
1999-04-01
1999-07-01
1999-10-01
2000-01-01
2000-04-01
2000-07-01
2000-10-01
2001-01-01
2001-04-01
2001-07-01
2001-10-01
2002-01-01
2002-04-01
2002-07-01

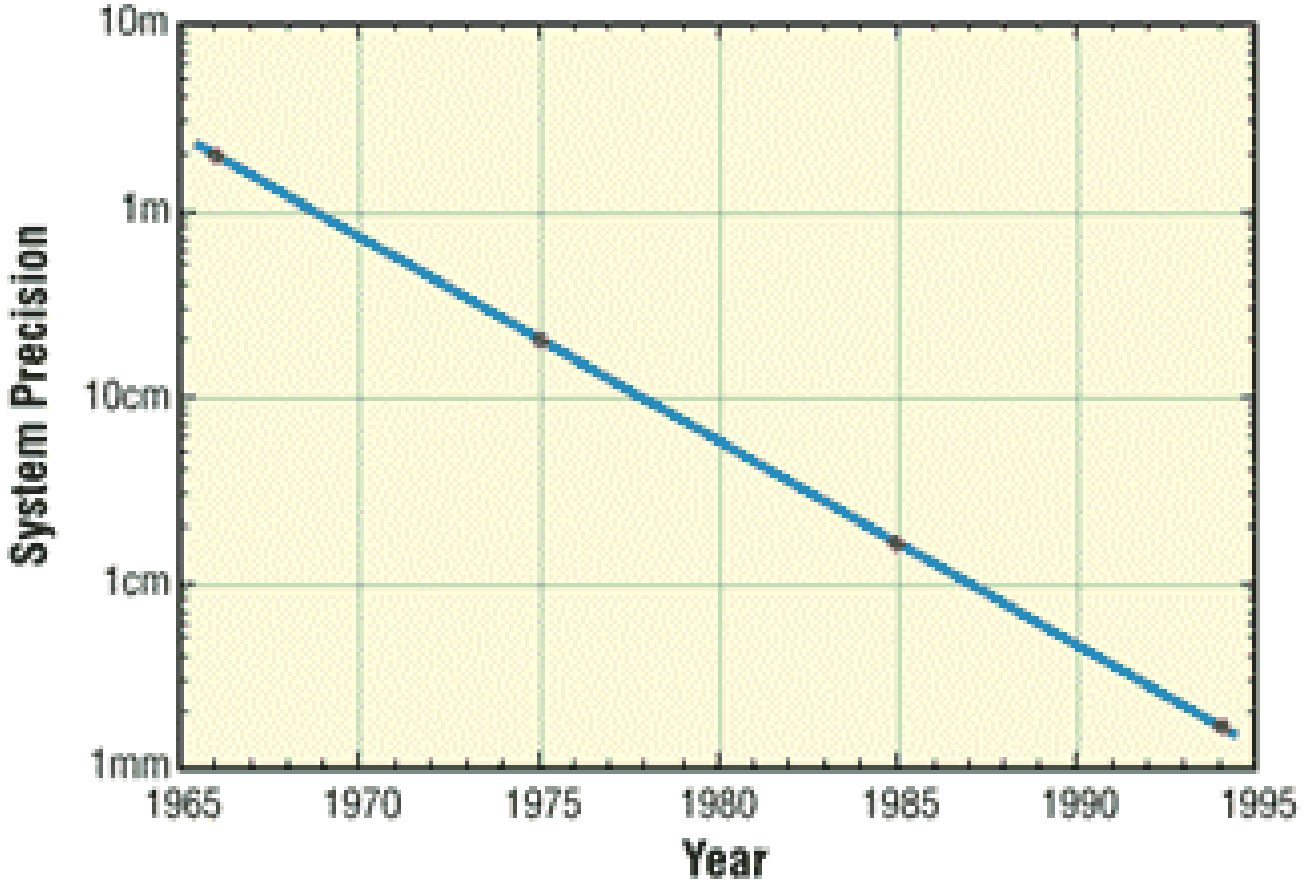

ENVISAT/ERS-2 Passes by Month
since 11 April 2002 (campaign start)
Number of Passes
ENVISAT
ERS-2
1000
900
800
700
600
500
400
300
200
100
0
Apr-02
May-02
Jun-02
Jul-02
Aug-02

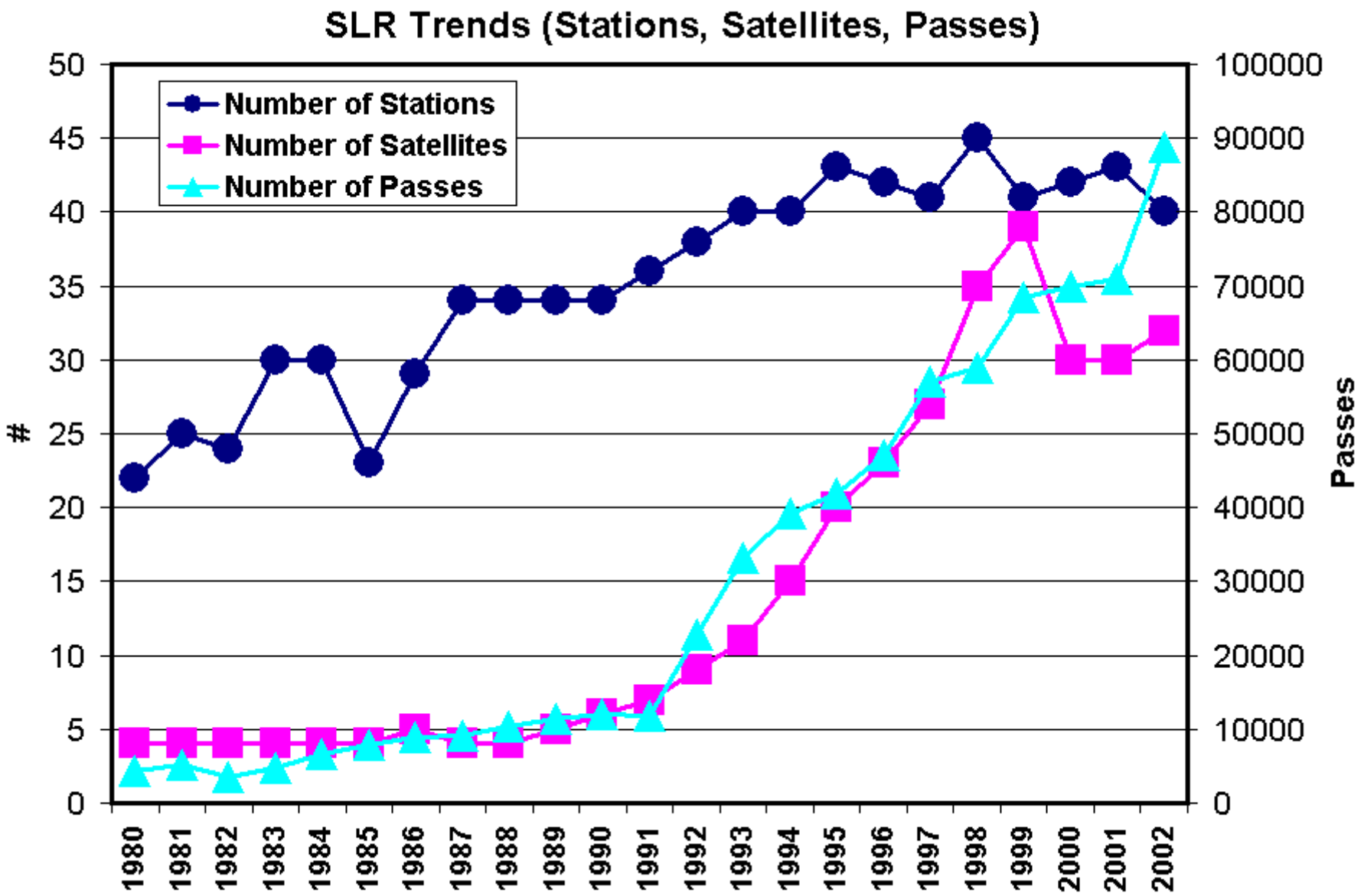

ERS-2 and Envisat Pass Totals
Passes
Percentage of Jason Passes
ERS-2
Envisat
% of Envisat Passes
400
350
300
250
200
150
100
50
0
100
75
50
25
0
Monument Peak
Graz
San Fernando
Greenbelt
Herstmonceux
Yarragadee
Grasse
Hartebeesthoek
Riga
Zimmerwald
Arequipa
Riyadh
Changchun
Ajaccio
Haleakala
Mt. Stromlo
Potsdam
Simeiz
McDonald
Wettzell
Tahiti
Simosato
Metsahovi2
Beijing
Shanghai
Katsively
Mendeleevo
Borowiec
Maidanak 1
Golosiiv
Komsomolsk
Matera (MLRO)
Maidanak 2
Concepcion


Topex Data Volume Time Series
12 month running average
Number of Passes
1400
1200
1000
800
600
400
200
0
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
Jan-00
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02
Jul-02


TOPEX/Poseidon and Jason Pass Totals
TOPEX/Poseidon
Jason 1
% of Jason 1 Passes
Passes
Percentage of Jason Passes
1500
1200
900
600
300
0
100
80
60
40
20
0
Yarragadee
Greenbelt
Herstmonceux
Ajaccio
Changchun
Grasse
San Fernando
Beijing
Riga
Potsdam
Shanghai
Simeiz
Simosato
Mendeleevo
Matera (MLRO)
Golosiiv
Borowiec
Maidanak 2

Single-Shot Precision Development




SLR Trends (Stations, Satellites, Passes)
Number of Stations
Number of Satellites
Number of Passes
#
Passes
0
5
10
15
20
25
30
35
40
45
50
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002

TOPEX/POSEIDON LRA RANGING CORRECTION
INPUT/OUTPUT PARAMETER MATRIX

GROUP 1 / GROUP 2

STATION	LASER PULSE WIDTH (ps)	DETECTOR			AMP BW (MHZ)	SIGNAL PROCESSING			RANGE CORRECTION	
		TYPE	IMPULSE RESPONSE (ps)	TEMPORAL PROFILE FILE		TECHNIQUE	CFD DELAY		ALGO-RITHM	TABLE#
							EXTERNAL (cm)	TOTAL (ps)		
MOBLAS - 4 *	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	13	1350	CFD	
MOBLAS - 5 *	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	12.1	1305	CFD	
MOBLAS - 7 *	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	14.2	1410	CFD	
MOBLAS - 8 *	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	13.3	1365	CFD	
TLRS - 1	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	15	1450	CFD	
TLRS - 3	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	13	1350	CFD	
TLRS - 4 *	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	12	1300	CFD	
TLRS - 2 *	150	MCP (2)	500	MCP2.DAT	?	CFD (a)	18.5	1625	CFD	
MLRS	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	13	1350	CFD	
HALEAKALA *	200	MCP (1)	600	MCP.DAT	N/A	CFD (a)	11.8	1290	CFD	
BAR GIYYORA *	200	MCP (1)	550	MCP.DAT	N/A	CFD (b)	12	1300	CFD	
ORRORAL *	110	MCP (1)	600	MCP.DAT	N/A	CFD (a)	12	1300	CFD	
WETTZELL	200	MCP (1)	700	MCP.DAT	1000	CFD (a)	37	2500	CFD	
MTLRS - 2	30	MCP (1)	550	MCP.DAT	?	CFD (b)	50	3200	CFD	
WUHAN *	150	MCP (1)	450	MCP.DAT	?	CFD (c)	5	950	CFD	
KATSIVELY *	350	MCP (5)	750	MCP.DAT	?	CFD (?)	60	3700	CFD	
HERSTMON.	80	APD/GM	N/A	N/A	N/A	N/A	N/A	N/A	SPAD	
MTLRS - 1 *	30	APD/GM	N/A	N/A	?	N/A	N/A	N/A	SPAD	
GRAZ *	35	APD/GM	N/A	N/A	N/A	N/A	N/A	N/A	SPAD	
FTLRS *	400	APD/GM	N/A	N/A	N/A	N/A	N/A	N/A	SPAD	
POTSDAM - 2	50	APD/GM	N/A	N/A	N/A	N/A	N/A	N/A	SPAD	

* Signal Strength Control

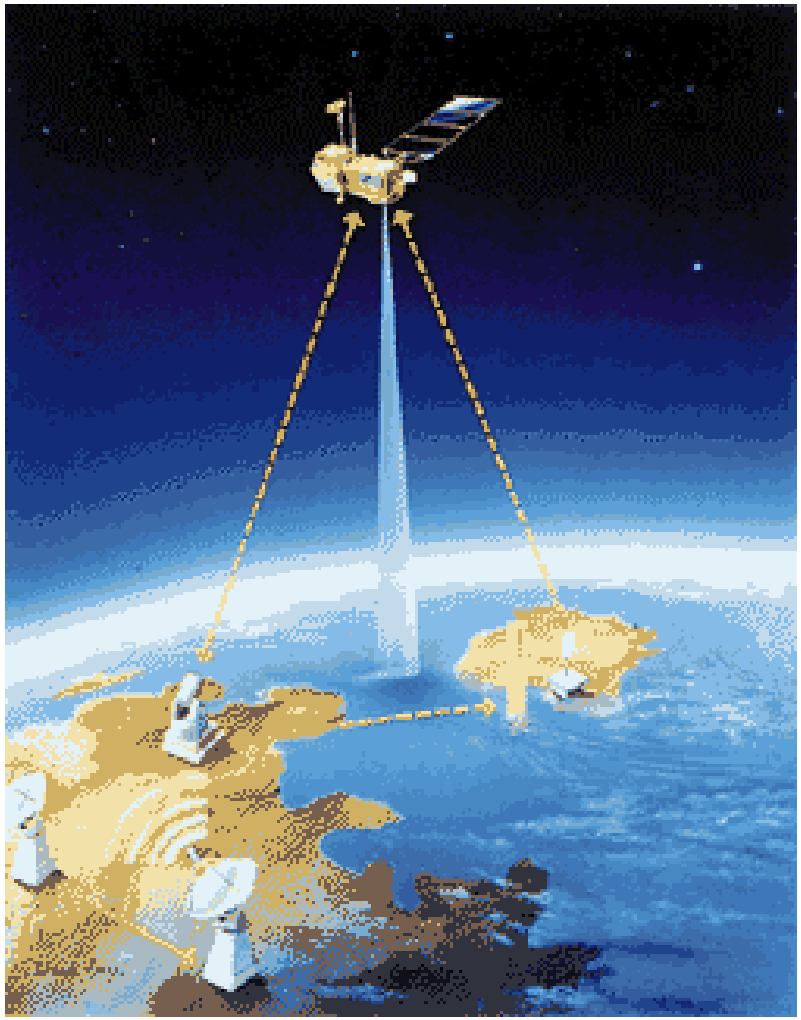
N/A- not applicable
#2 Lasers at this site

1 - ITT F 4129F
2 - ITT F4128F
3 - RCA 8850
4 - XP2233B RTC
5 - FUE -165
6 - GDB - 49
7 - HAMAMATSU R1828-01
8 - PHILIPS PM 2233
9 - RCA 8852
10 - HAMAMATSU R22024U
11 - EMI D341B
12 - FUE-79
13 - RCA C31034A
14 - RCA 31034
15 - EMI9883B

a - TENNELEC TC454
b - ORTEC 934
c - CANBERRA 1428A
d - NORTH CHINA INSTITUTE
e - ORTEC 473A
f - IN HOUSE DESIGN
g - B-6
h - MOTOROLAMC1651
i - LECROY821

Current and Future SLR Contributions to Altimeter Missions

- Calibration Altimeter Instrument
- Determination Satellite Orbit
- Calibration Satellite Orbit
- Validate Gravity Field Solution
- Geocenter, Scale
- ……



SLR Measurement Error Assessment

(all values in mm)

• Single-shot data noise	4 – 7 (NP: < 1)
• Calibration	1
• Troposphere	2 – 3
• Center-of-mass	2 – 3
•….	