Tracking Strategies and Priorities for Laser Ranging

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October 10, 2016
20th International Workshop on Laser Ranging
Potsdam, Germany

Current Situation

- The SLR network currently tracks about 90 satellites from LEO to synchronous altitudes;
- Incoming/stored data include all of the satellites tracked from any CPF's provide;
- Need to determine who is using the data and what he is doing with it;
- Data volume varies greatly from station to station;
- Results depend on weather, local technology, level of support, etc, but probably also tracking procedure/on site priorities;

- Can we expand data yield on satellites that are most important, without leaving anybody behind?
- We want to share some of the tracking and scheduling procedures that stations use.

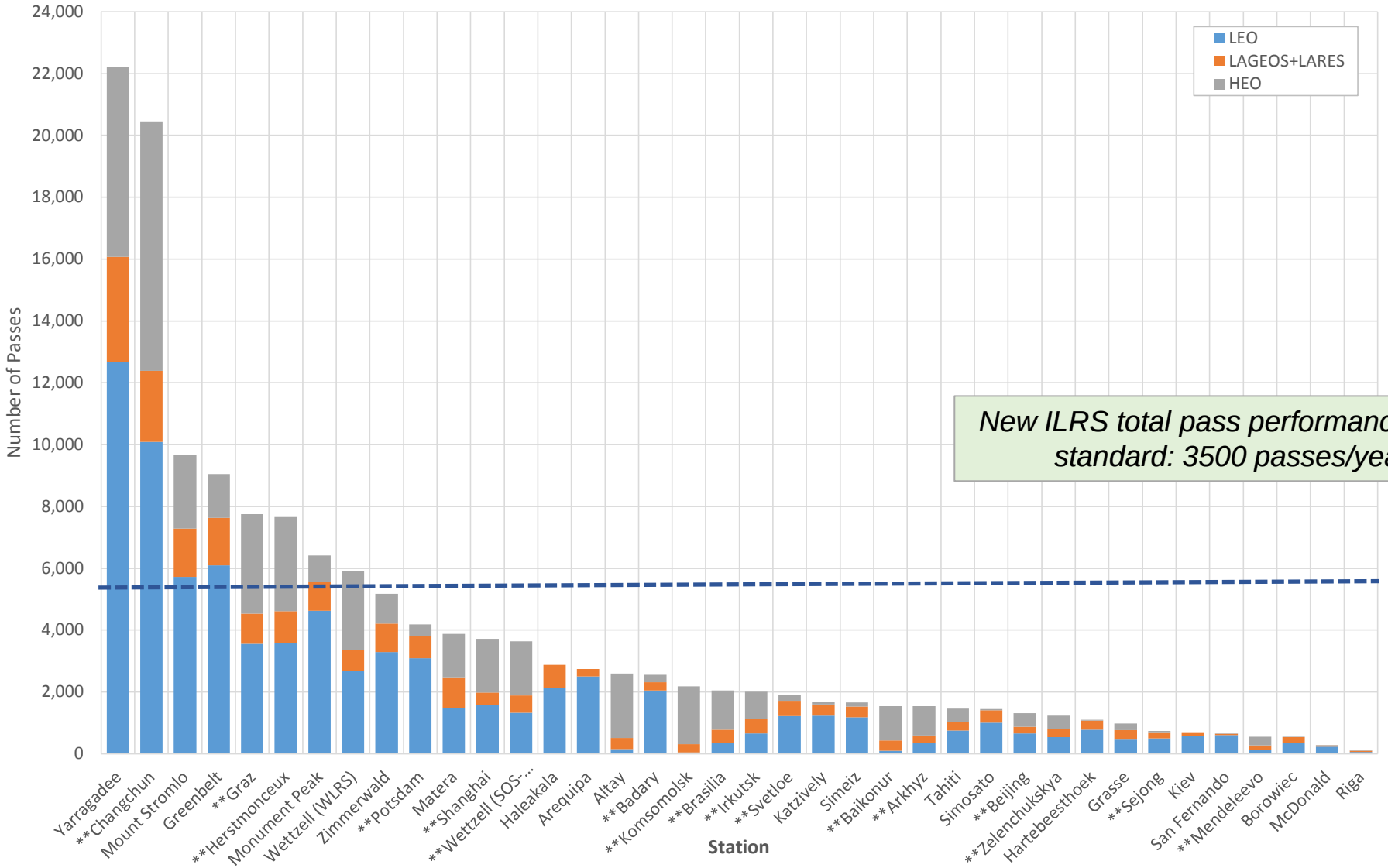
Tracking priorities

- The ILRS has ordered its tracking priority list according to satellite orbital parameters and special project needs. Tracking priorities have been ordered as follows:
- Priorities decrease with:
  - increasing orbital altitude; and
  - increasing orbital inclination (at a given altitude).
- Priority of some satellites may then be increased to intensify support for:
  - active missions (such as altimetry);
  - special campaigns (GREAT Experiment); or
  - post-launch intensive tracking phases; and
- Some slight reordering may be done to give higher priority missions with increased importance to the analysis community.
- Stations may adjust priorities to accommodate local conditions such as system capabilities, weather, and special program interests.
- *Satellite sponsors request for tandem mission, satellites be tracked on alternate passes.*

Total passes (10/2015-09/2016)

Site Name	GRACE	Jason	Star+Stel	LARES	LAGEOS	Etalon	Ajisai	Galileo	GLONASS	Compass	Other Sats.	Totals
Altay	2	2	28	118	247	48	14	160	1,815	21	142	2,597
Arequipa	61	244	540	137	112	0	400	0	0	0	1,251	2,745
Arkhyz	0	74	81	76	189	38	112	79	815	6	64	1,534
Badary	46	218	426	153	123	3	372	0	227	0	982	2,550
Baikonur	0	0	19	26	310	50	0	221	796	41	74	1,537
Beijing	38	117	122	62	152	22	98	41	327	48	290	1,317
Borowiec	16	57	54	75	116	0	40	3	3	0	182	546
Brasilia	2	45	97	51	395	0	74	276	974	20	115	2,049
Changchun	509	1,602	1,365	928	1,366	394	1,041	1,683	4,726	818	6,025	20,457
Grasse	0	457	0	0	302	14	0	184	0	0	22	979
Graz	166	629	597	384	591	156	385	839	2,128	64	1,810	7,749
Greenbelt	342	828	902	458	1,076	163	629	386	841	36	3,390	9,051
Haleakala	63	288	391	164	575	0	246	0	0	0	1,145	2,872
Hartebeesthoek	18	117	149	89	203	5	139	8	17	0	357	1,102
Herstmonceux	201	690	447	374	668	182	300	819	1,891	98	1,990	7,660
Irkutsk	3	111	187	121	357	27	165	63	770	6	192	2,002
Katzively	20	147	243	138	218	23	206	17	49	3	616	1,680
Kiev	4	74	118	48	58	0	142	0	0	0	233	677
Komsomolsk	0	3	8	70	193	36	13	77	1,737	15	24	2,176
Matera	24	224	434	226	769	218	244	570	538	50	576	3,873
McDonald	0	27	48	16	26	0	34	5	5	0	123	284
Mendeleevo	9	39	14	28	106	14	17	20	237	8	55	547
Monument_Peak	246	567	586	301	635	68	591	286	474	28	2,633	6,415
Mt. Stromlo	223	810	1,147	458	1,106	118	952	939	1,198	109	2,601	9,661
Potsdam	172	599	444	337	384	10	321	94	272	1	1,554	4,188
Riga	2	0	11	16	19	1	10	2	0	0	37	98
San Fernando	10	29	86	12	15	0	110	0	20	0	376	658
Sejong	0	42	158	58	113	0	152	2	63	1	146	735
Shanghai	93	180	301	142	270	89	232	310	1,082	191	829	3,719
Simeiz	14	196	236	138	213	6	201	7	114	7	534	1,666
Simosato	15	107	210	111	293	5	238	0	26	0	437	1,442
Svetloe	33	199	173	195	299	2	144	18	172	2	672	1,909
Tahiti	35	116	155	86	182	50	111	137	222	28	334	1,456
Wettzell (SOS-W)	75	325	251	223	342	115	148	424	1,171	30	532	3,636
Wettzell (WLRS)	50	520	563	281	403	171	462	812	1,526	33	1,085	5,906
Yarragadee	769	1,943	1,796	956	2,425	723	1,473	2,130	2,423	524	7,050	22,212
Zelenchukskya	4	56	122	77	181	18	107	27	393	0	252	1,237
Zimmerwald_532	189	493	565	347	576	77	381	253	575	43	1,673	5,172
Totals:	3,454	12,175	13,074	7,480	15,608	2,846	10,304	10,892	27,627	2,231	40,403	146,094

Total passes (10/2015-09/2016)



New ILRS total pass performance standard: 3500 passes/year

*** Indicates high-repetition site*

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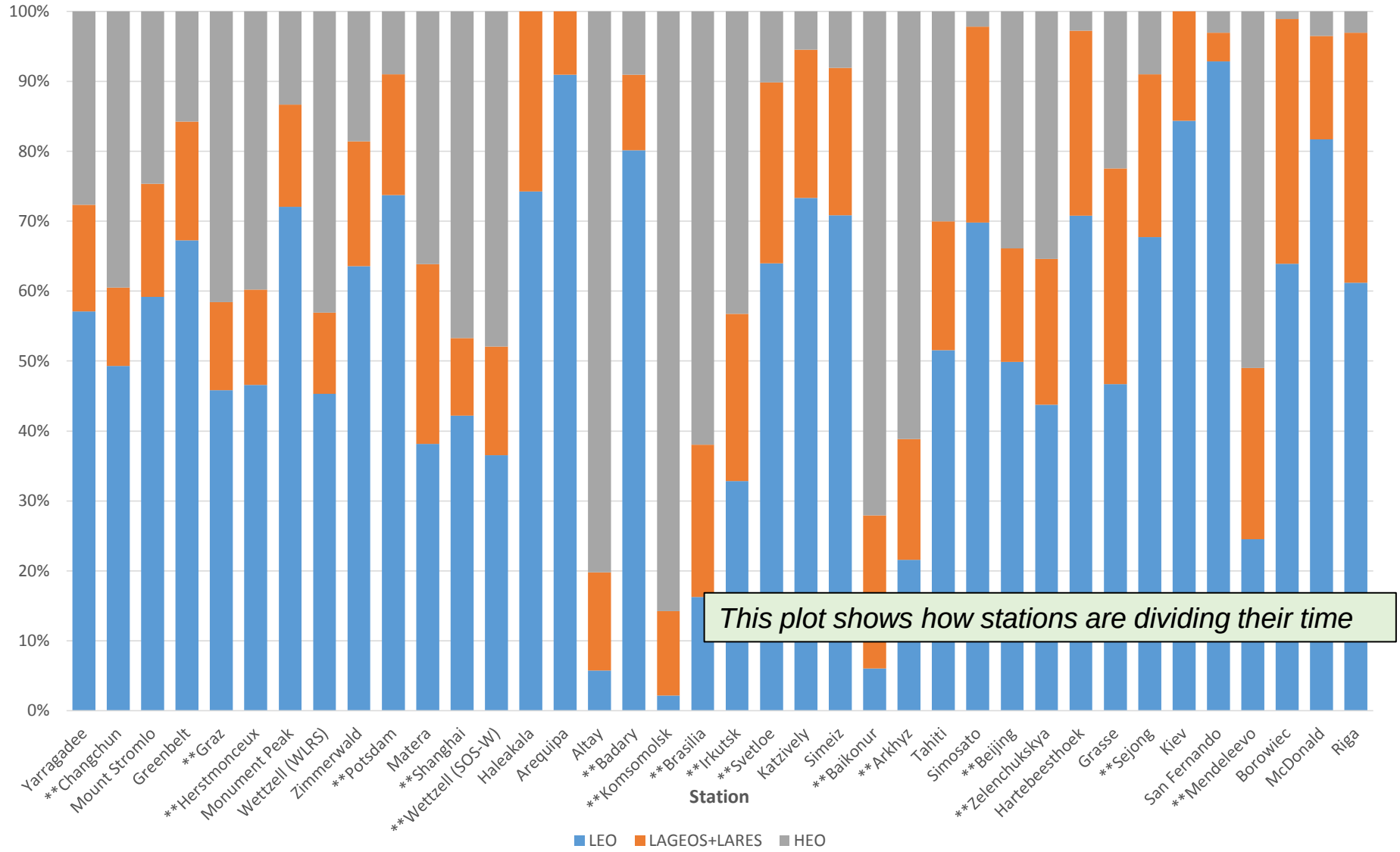

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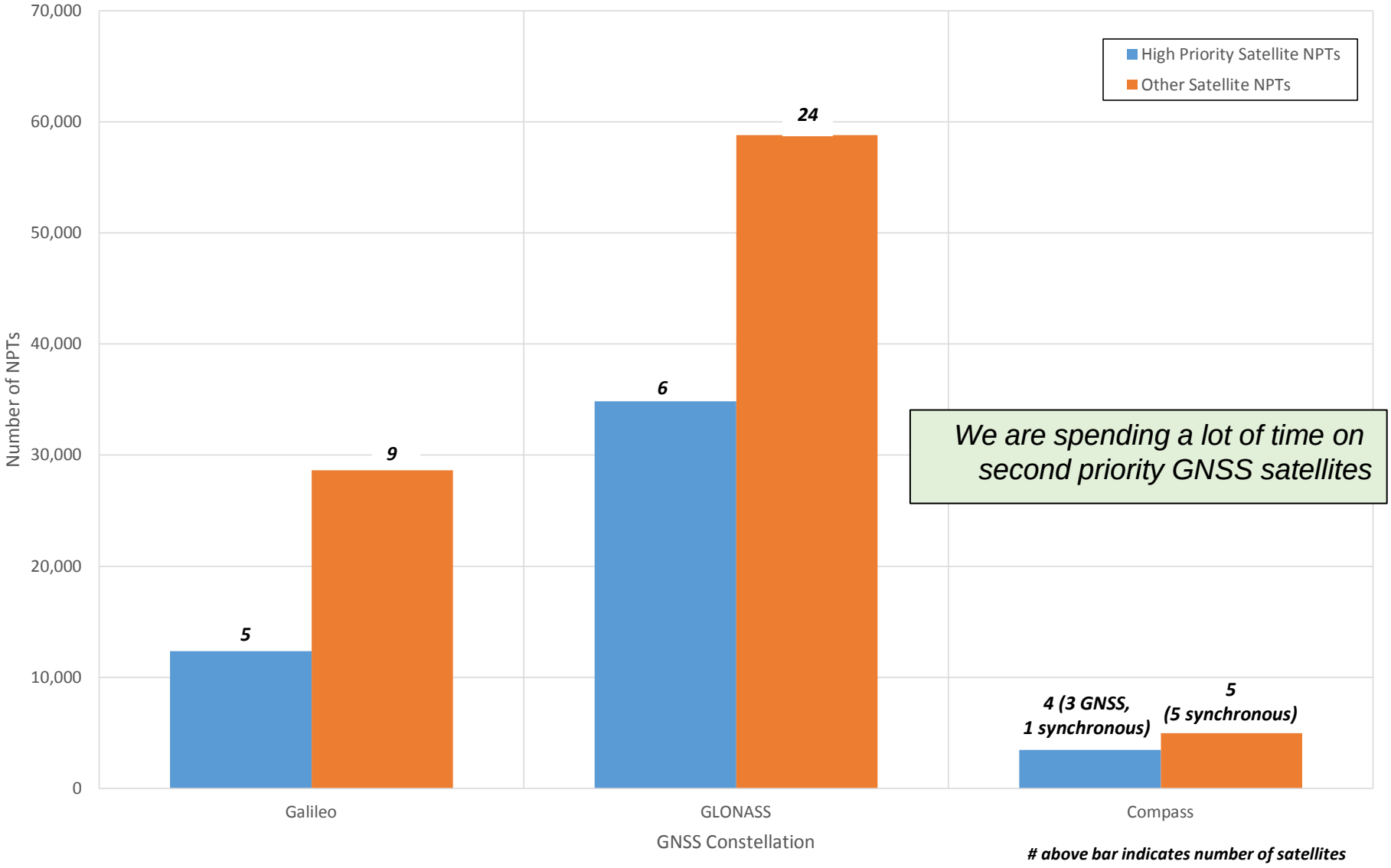
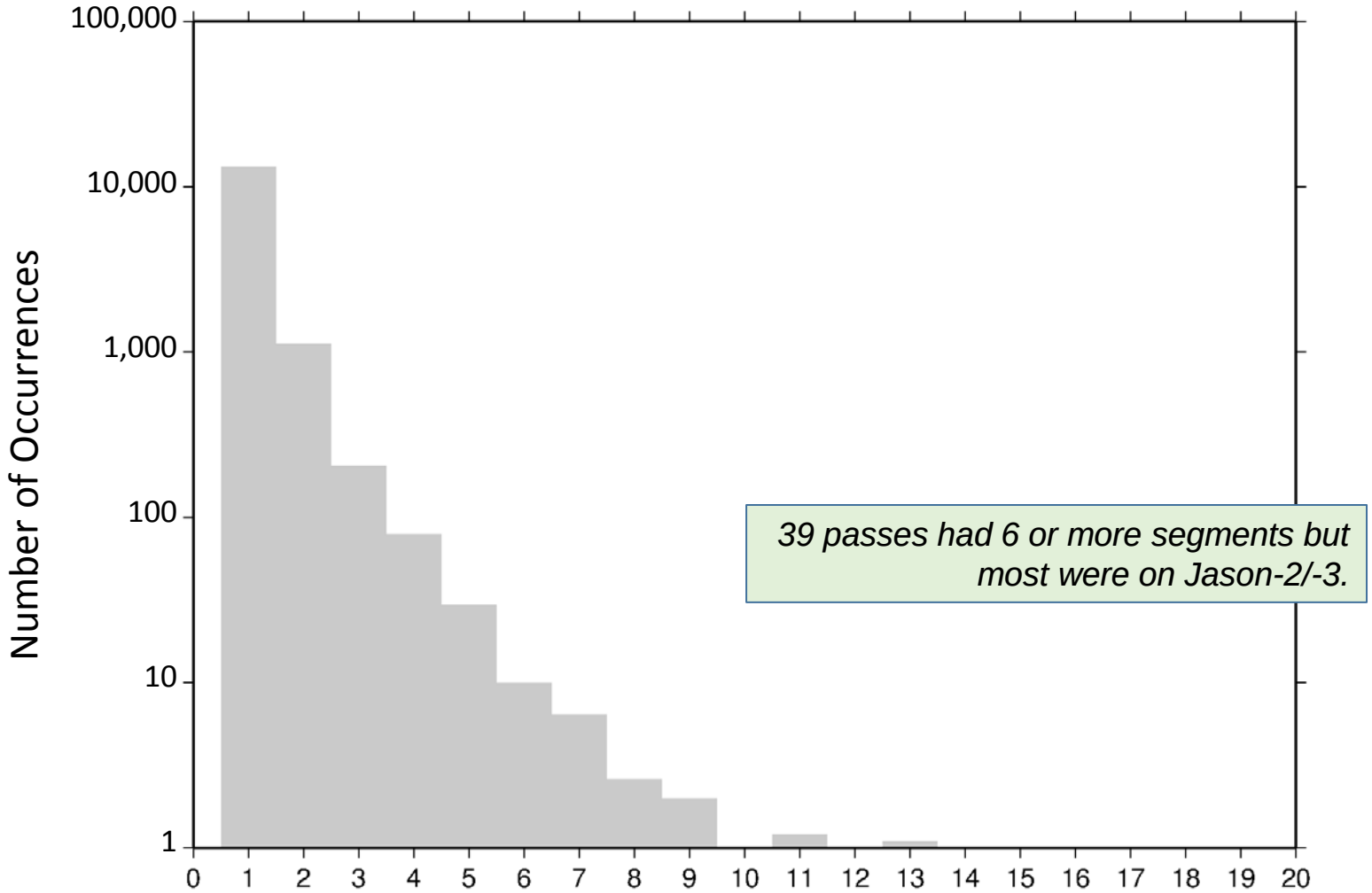
Tracking of GNSS constellations

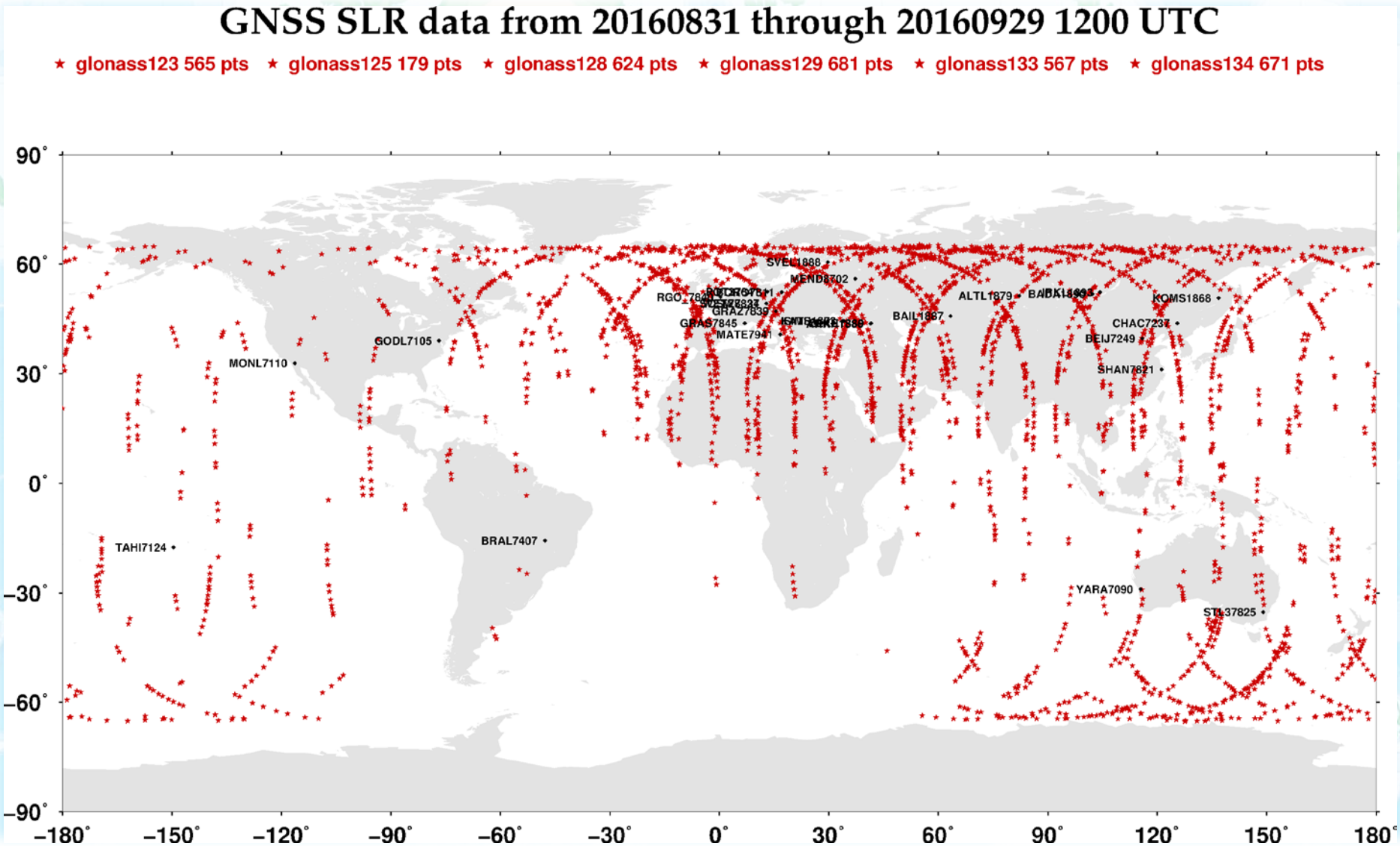


Number of segments/pass (10/2015-09/2016)



39 passes had 6 or more segments but most were on Jason-2/-3.

GLONASS tracking (1 month)



Questions for discussion

- If we track fewer GNSS satellites can we get more data on the higher priority satellites?
- Are there tracking strategies that might help stations?
- Are the new technology stations getting more data?
- Would time and station segmentation assignments improve the network performance?
- Should we set tracking limitations on some satellites (e.g., Ajisai)?

LARGE Project-4 (suggestion from our Russian colleagues)

- Goal:
  1. Achieve the maximum accuracy of the laser orbit on a GNSS Satellite using GLONASS as a test;
  2. Organize a campaign to compare radio, VLBI and SLR techniques for orbit determination results;
- Method:
  - Reduce the number of GLONASS satellites to four;
  - Select the satellites for the best operational conditions;
  - Ask each GNSS capable SLR station to get one normal point on each satellite every 20 minutes while the satellite is above 20 degrees elevation, in daytime and night time;
- Study:
  - Determine the required SLR coverage required to achieve sub-cm orbits over 2 – 4 day periods;
  - Examine the possibility of conducting VLBI sessions in GNSS satellites as part of a multi-technique experiment.

Session 1 Agenda

Speaker	Title
Mike Pearlman	Introduction
Sergey Martynov	Methods for coordinate and time data collection in the laser station "Tochka"
Rob Sherwood	Multi-satellite tracking at SGF Herstmonceux
David McCormick	NASA SLR Network scheduling and considerations for improvement
Randall Carman	Yarragadee SLR station (MOBLAS-5) scheduling and optimal tracking strategies
Florian Andritsch	Simulation of realistic SLR observations to optimize tracking scenarios
Toshimichi Otsubo	Satellite laser ranging network: Where should a new station be placed?
	Discussion